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MINERALOGY
OF THE
SCOTTISH ISLES;

WITH
MINERALOGICAL OBSERVATIONS
MADE IN A *TOUR* THROUGH DIFFERENT PARTS OF
THE MAINLAND OF SCOTLAND,
AND
DISSERTATIONS
UPON
PEAT AND KELP.

IN TWO VOLUMES.

Illustrated with Maps and Plates.

BY
ROBERT JAMESON,
FELLOW OF THE ROYAL AND ANTIQUARIAN SOCIETIES OF EDINBURGH,
LINNÆAN SOCIETY OF LONDON, PHYSICAL SOCIETY
OF JENA IN SAXONY, &c.

*Observationes veras, quam ingeniosissimas fictiones sequi præstat; Naturæ
mysteria potius indagare quam divinare.*

BERG. De Form. Crystallor.

VOL. II.

EDINBURGH: PRINTED BY C. STEWART & CO.
FOR B. WHITE & SON, FLEET-STREET, LONDON; AND W. CREECH, EDINBURGH.

1800.

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OF THE

SCOTTISH HILLS

MINERALOGICAL OBSERVATIONS

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OF JENA IN SAXONY, &c.

Observations on the various kinds of peat, and the manner in which it is used for fuel; and on the various kinds of kilns, and the manner in which they are used for burning lime, &c.

By Robert Jameson, Esq.

Edinburgh: Printed by J. Macfarlane, 1804.

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FOR N. WHITE & SONS, 11, MARK LANE, LONDON; AND W. LEITCH, EDINBURGH.

1804

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TO

CHARLES HATCHET, ESQ.

FELLOW OF THE ROYAL SOCIETIES

OF LONDON AND EDINBURGH,

OF THE LINNÆAN SOCIETY, ETC.

THIS VOLUME,

AS A MARK OF GREAT RESPECT

AND ESTEEM

OF HIS SUPERIOR MINERALOGICAL ATTAINMENTS,

IS INSCRIBED,

BY

THE AUTHOR.

SHERIFF-BRAE, LEITH,
20. JULY, 1800.

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VOL. II.

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MAP
of the
Shetland Islands
EXCERPTED FOR AN OUTLINE



MINERALOGY
OF THE
SCOTTISH ISLES.

VOLUME II.

I-COLUMB-KILL AND STAFFA.

CHAP. XVI.

Outline of the MINERALOGY of I-COLUMB-KILL and STAFFA.

I-COLUMB-KILL.

THIS island is mentioned by writers under the different names of Hii, Iona, and I-columb-kill; but it is now generally denominated by the inhabitants I, or I-columb-kill: the

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A

latter

latter name being derived from St. Columba, the tutelary saint of the Hebrides. It is about three miles long, and from half a mile to a mile and a half in breadth. It is low, (yet not without hills, of which Dun-ii is the highest,) bare and rugged, excepting in the neighbourhood of the religious houses, where the ground is flat and cultivated, yielding about 140 l. per annum, which is nearly the rent of the whole island. The shores are in general low and rocky, yet in a few places there are pretty high cliffs.

HISTORR. The early history of this island is involved in the general obscurity which veils the ancient history of Scotland; so that the many traditional tales concerning it, which have reached our times, are not worthy of serious attention. The most ancient written records that concern it, are not earlier than the æra of the landing of St. Columba. This remarkable man left Ireland, his native country, not, as Mr Pennant remarks, from discontent, but with the noble and generous intention of dissipating the ignorance which then covered the Hebrides. He landed finally upon I, where he built religious houses; and the island was soon afterwards presented to him by Connal king of Scotland. Having contributed much to the diffusion of Christianity through the wilds of the Hebrides, and other parts of Scotland, he died, at the age of seventy-seven.

ven. He was certainly a man of much piety and goodness of heart; and his manners, altho' extremely austere, were well calculated for the people of the age in which he lived. For two hundred years after his death, the religious of this isle lived quietly, and in the high estimation of all the country. About the year 716, the ferocious Danes, who had harassed every part of Scotland with their barbarous invasions, at length disturbed this seat of religion and learning; massacred the greater part of the monks, and drove the remainder from the island. Some time afterwards the whole of the Western Islands were subjugated to the regular Danish government, when many of the monks again returned to I. From this period, however, the college of I gradually declined, until the twelfth century, when the Romish priests having got possession of all the monasteries, the Culdees, or sect of St. Columba, were dispersed, and gradually sunk from notice, leaving behind them a high reputation for learning and virtue.

MINERALOGY. At the usual landing place, from Rofs in Mull, the shore is rugged, and formed of a rock which appears to be composed of quartz pretty intimately combined with chlorite, and hornblende. It is, however, subject to much variety; for it is observed passing on the one hand to hornblende

A 2

rock,

rock, and ardefia; and on the other, into a filiceous talcaceous shiftus *. It is traversed with veins of the granites garbenbergensis of Linnæus, a rock which is composed of quartz and mica. As we proceeded on towards the N. end of the island, we examined the venerable ruins of the Cathedral, and other houses, which were formerly the residence of the religious of the North; "whence savage clans, and roving barbarians, derived the benefits of knowledge and the blessings of religion." The description of these buildings, would be interesting to the antiquary; but it is an object unconnected with my present pursuit; and besides, they have been illustrated by the descriptions and drawings of Mr Pennant, and Dr Garnet. I regret much, however, that I am prevented from communicating to the public, the elegant and truly characteristic drawings made by my friend Mr Bell: they are the only ones I have ever seen that convey a complete idea of these remarkable ruins.

The strata which we observed at the landing place, continue to the N. E. extremity of the island, when they give place to hornblende slate, sienite, and hornblende rock having much the

* Mr. Mills says, that the rock at the landing place is laminated hornstone. Philosophical Transactions of the Royal Society of London, 1790, p. 77.

the appearance of serpentine. These rocks alternate with each other, and are to be observed traversed by basalt and granite veins. From this to Dun-ii, the highest hill in the island, the hornblende and sienite strata, continue forming, upon some parts of the coast, cliffs of considerable height. We ascended to the summit of this hill, which I found to be composed of primitive rock; and principally of hornblende slate. As we walked onwards, by the west side, to the southern extremity of the island, we saw upon the coast several sandy beaches and steep cliffs; and the strata continued to Porta-curach, to be hornblende slate, and sienite, traversed with basalt and granite veins. We observed at a distance, two shelving rocks of a green colour; which are probably of the nature of serpentine, or hornblende. At Porta-curach, or St. Columba's landing place, there are cliffs of considerable height, which are composed of strata of hornblende rock, having much the appearance of serpentine, and sienite. These strata are traversed with veins of granite, and veins of quartz, (which have a light fiskein-green colour, owing to its admixture with hornblende,) are also to be observed. The beach is covered with numberless rounded fragments of marble, quartz, of an amethystine hue, fiskein-green-coloured quartz, and lapis nephriticus. We now walked across this island, over the usual hornblende and other rocks, to the marble quarry. This marble,

or

or what is now called dolomite, forms a great stratum about 40 feet wide, running N. N. W. and S. S. E. and bounded by nearly vertical strata of a rock which is in some parts of the nature of shistose talc or passing to chlorite slate *. The marble as it approaches the other strata, is more or less mixed with talc, which causes it to become scaly or fibrous, with a yellowish green colour; thus approaching to the nature of talcaceous shistus. I often also observed masses of nephrite, and of fine green talcaceous shistus, immersed in the marble; the nephrite appears to have been formed at the same time with the marble, as I observed it disseminated and combined with it in a similar manner as the hornblende in the fiske-green quartz; the talcaceous shistus, however, is dispersed in large irregular masses that seem to have been broken off from the neighbouring strata. From the marble quarry to the landing place, the shore is bare and rugged; and the strata do not differ from those we have already described. At a little distance from it, we observed several islands and rocks, entirely composed of red granite: thus rendering it probable, that this island was formerly joined with the granite coast of Ross, in Mull.

Dr.

* Upon one side of the stratum, I observed a layer of felspar; which is intermixed with quartz, passing to hornstone.

Dr. Garnet, in his lately published tour through the Highlands, remarks, that the greater part of this island is formed of limestone; and that the strata are all of secondary formation. The first observation, as far as my experience goes, is incorrect; for after having walked around a considerable part of the island, I only found marble in one place; and was informed, that it had been observed in another spot. The other observation is contradicted by the account I have just given of the strata of the island.

STAFFA.

AS I had not an opportunity of landing upon this remarkable island, I am prevented from giving any description of the rocks of which it is composed, from my own observations; I will, therefore, give a short account of it drawn from the accounts of others; which I have confirmed and corrected by specimens brought from the island.

The

STAFFA.

This isle is about one mile long, and half a mile broad, and nearly two miles in circumference. It is not very high; the highest part, which is that immediately above Fingal's cave, being about 114 feet above the level of the sea. Its coast is steep, and bounded by magnificent basaltic colonades; which are in several places broken into caves; and of these, the most remarkable is that called Fingal's cave. It is not above 25 years since the wonders of this little spot were made known to philosophical enquirers, by Sir Joseph Banks, who communicated his elegant drawings and description, to the late Mr. Pennant. This will not appear surprising, if we consider that those, who are accustomed to travel frequently among the Hebrides, become so much accustomed to the appearance of basaltic colonades, that it requires something very extraordinary to excite their curiosity. Staffa, even at no great distance, has a more diminutive appearance, than other basaltic rocks, which are by no means so magnificent; and probably, from this circumstance, it long escaped the attention even of the gentlemen of this neighbourhood. The emotions excited by the view of this magnificent scene, are thus expressed by the learned President of the Royal Society: "At nine o'clock, (says he,) after
" a tedious passage, having had not a breath of wind, we arrived, under the direction of Mr. Maclean's son, and Mr.
" Leach. It was too dark to see any thing, so we carried our
tent

“ tent and baggage near the only house upon the island, and
“ began to cook our supper, in order to be prepared for the
“ earliest dawn, to enjoy that which, from the conversation of
“ the gentlemen, we had now raised the highest expectations of.
“ The impatience which every body felt to see the wonders we
“ had heard so largely described, prevented our morning rest ;
“ every one was up and in motion before the break of day ;
“ and with the first light arrived at the south-west part of the
“ island, the seat of the most remarkable pillars, where we
“ no sooner arrived, than we were struck with a scene of mag-
“ nificence which exceeded our expectations ; though formed,
“ as we thought, upon the most sanguine foundations ; the
“ whole of that end of the island, supported by ranges of na-
“ tural pillars, mostly above fifty feet high, standing in natural
“ colonnades, according as the bays or points of land formed
“ themselves ; upon a firm basis of solid unformed rock, above
“ these, the stratum which reaches to the surface or soil of the
“ island, varied in thickness, as the island itself formed into
“ hills or vallies ; each hill, which hung over the columns be-
“ low, forming an ample pediment ; some of these above 60
“ feet in thickness, from the basis to the point, formed by the
“ sloping of the hill on each side, almost into the shape of those
“ used in architecture. Compared to this, what are the cathe-
“ drals or the palaces built by men : mere models or play
Vol. II. B “ things ;

“ things ; imitations as diminutive as his works will always be
 “ when compared to those of nature. Where is now the boast
 “ of the architect ! regularity, the only part in which he fan-
 “ cied himself to exceed his mistress, nature, is here found
 “ in her possession ; and here, it has been for ages undescrib-
 “ ed. Is not this the school where the art has been originally
 “ studied ; and what has been added to this by the whole Gre-
 “ cian school ? a capital to ornament the column of nature,
 “ of which they could execute only a model ; and for that very
 “ capital, they were obliged to a bush of acanthus : how am-
 “ ply does nature repay those who study her wonderful works !
 “ With our minds full of such reflections, we proceeded along
 “ the shore, trading upon another Giants causeway ; every stone
 “ being regularly formed into a certain number of sides and
 “ angles ; till in a short time, we arrived at the mouth of a
 “ cave, the most magnificent, I suppose, that has ever been
 “ described by travellers.

“ The mind can hardly form an idea more magnificent than
 “ such a space, supported on each side by ranges of columns,
 “ and roofed by the bottoms of those which have been broke
 “ off in order to form it : between the angles of which, a yel-
 “ lowish stalagmitical matter has issued, and serves to define
 “ the angles precisely ; and at the same time, vary the colour

“ with

“ with a great deal of elegance ; and to render it still more
 “ agreeable, the whole is lighted from without ; so that, the
 “ farthest extremity, is very plainly seen from without ; and
 “ the air within, being agitated by the flux and reflux of
 “ the tides, is perfectly dry and wholesome ; free entirely
 “ from the damp vapours, with which, in general, natural ca-
 “ verns abound.” The learned Bishop of Linköping, re-
 marks, “ how splendid do the porticos of the ancients appear
 “ in our eyes, from the ostentatious magnificence of the des-
 “ cription we have received of them ; and with what admira-
 “ tion are we seized, on seeing even the colonades of our mo-
 “ dern edifices ! But when we behold the cave of Fingal, for-
 “ med by nature in the island of Staffa, it is no longer possible
 “ to make a comparison ; and we are forced to acknowledge,
 “ that this piece of architecture, executed by nature, far sur-
 “ passes that of the Louvre ; that of St. Peter’s at Rome ; and
 “ even what remains of Palmyra and Paestum ; and all that the
 “ genius, the taste, and the luxury of the Greeks, were ever ca-
 “ pable of inventing.”

Such were the very strong impressions which the columnar
 rocks of Staffa made on the learned gentlemen who first explor-
 ed them ; and we are not to be surprized, that the contempla-
 tion of scenery so new and striking, should have raised in their

minds a picture, which to other travellers may seem over-coloured. Although I had not an opportunity of landing on the island, yet from what I saw, and have frequently been told, I do not in the least doubt that the ruins of Palmyra, or the vast remains of Egyptian architecture, would more powerfully interest the feelings, than all the wonders of Staffa. But this is mere matter of opinion; I will therefore pass to the account of its mineralogy.

From all the accounts which have been published, and the specimens which I have examined, the island seems to be principally formed of basalt and wacken. The basalt is generally in the form of columns, which are, 1. Triangular: of this form, there are specimens in the museum of the University. 2. Quadrangular. 3. Pentagonal. 4. Hexagonal. 5. Heptagonal. 6. Octagonal. 7. Articulated like the Giants causeway or those of the beautiful columns at Dunbar harbour. 8. Jointed without the convex or concave extremities. These pillars generally rest upon a basalt tuff or breccia *, and the strata of basalt columns (as is the case in other parts of Scotland,) follow the more or less inclined direction of the tuff or breccia. The colonades are usually covered

* Faujas' Travels, vol. 2. p. 58. 59. He there names the basalt tuff, gravelly lava.

covered by a thick stratum of basalt, which has sometimes an irregular columnar shape. Mr. St. Fond also mentions, that he observed cubical zeolite, octogonal semitransparent zeolite: white semitransparent zeolite, in crystals of thirty facettes: this is probably leucit: and also zeolite passing to chalcedony.

Both Mr St Fond, and Mr Mills, inform us, that they found granite among the rolled stones upon the shore of the island. These are either derived from the basalt tuff, or they have been conveyed by currents from the neighbouring granite coast of Ross: but the first supposition seems the most probable.

I-CQ-

This quartz which forms a part of the granite, and horn-
blende rock of I-column-kill, has often a white or bluish colour,
with the usual lustre, transparency, fracture, and hardness;
but it is also liable to considerable variety; owing to its being
more or less intermixed with hornblende. With a very small
admixture of hornblende it acquires a greasy lustre; and has
a hardly perceptible bluish-green colour: with a greater por-
tion of hornblende, it has a pale bluish-green colour,
with

I-COLUMB-KILL.

CHAPTER XVII.

Description of the FOSSILS mentioned in the preceding Chapter.

Sisikin-green coloured QUARTZ of *I-columb-kill*.

The quartz which forms a part of the sienite, and hornblende rock of *I-columb-kill*, has often a white or bluish colour, with the usual lustre, transparency, fracture, and hardness; but it is also liable to considerable variety; owing to its being more or less intermixed with hornblende. With a very small admixture of hornblende, it acquires a greasy lustre; and has a hardly preceptible sisikin-green colour: with a greater proportion of hornblende, it has a pale sisikin-green colour, with

with a weak degree of lustre and transparency, and a plain splintery, or imperfectly conchoidal fracture: and lastly, with a still greater quantity of hornblende, it has a dark fiskin-green colour, with little transparency, and a coarse splintery fracture.

Dark, approaching to leek-green coloured FELSPAR—

I-columb-kill.

The felspar of the sienite is generally of a brick or flesh-red colour; but is also of various shades, from pale to dark leek-green: this is owing to its being more or less penetrated with chlorite or hornblende.

HORNBLENDE ROCK, having the appearance of serpentine—*I-columb-kill.*

This rock is of a dark green colour, and is composed of minute crystals of hornblende, with a small portion of quartz; which has a dark fiskin-green colour. Similar rocks have been observed in other countries: thus Humboldt and Charpentier, in their dispute with regard to the magnetic property of a serpentine rock, remark, that it has often a great resemblance.

blance to hornblende rock*; and Mr Kirwan in his geological Essays, hints, that hornblende rocks may be mistaken for serpentine. The greater specific gravity, and the crystalline texture of the hornblende rock, distinguish it from serpentine.

MARBLE, or DOLOMITE, of I-columb-kill.

Colour. Snow-white, but frequently verging to yellow, or fawn-green, from the admixture of talc.

Lustre. Hardly perceptible, and only from a few dispersed foliae.

Fracture. Splintery, passing to the even; rarely granular foliated, and sometimes imperfectly shistose.

Transparency. Transmits light at the edges.

Hardness. Yields with difficulty to the knife.

Chemical character. Dissolves very slowly in acids, which is a good test for distinguishing it from other kinds.

* Neuis Bergmannischis Journal.

According to Mr Tennant, 25 grains afford, of carbonic acid and water about 12, magnesia 4.4, lime 7.8, and 1.0 insoluble substance.

Use as a Manure. As this marble contains a considerable portion of magnesian earth, it is probable that it will produce similar effects, when laid on the ground, with the magnesian limestone examined by Mr Tennant *. I shall therefore mention the fact which he discovered; as it will be of consequence, not only to the inhabitants of this isle, but to farmers in general. This gentleman informs us that, in the neighbourhood of Doncaster, two kinds of limestone are employed in agriculture: the one, which contains two thirds of magnesian earth, must be used sparingly, and spread evenly over the ground; for, if used abundantly, it diminishes the fertility of the soil, and prevents vegetation for several years: the other, which is pure limestone, altho' laid upon the ground in great quantities, is never injurious—on the contrary, produces much fertility. Farmers should therefore be careful to examine whether the limestone they are to employ dissolves slowly in acids; as this

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* Philosophical Transactions of the Royal Society of London, 1799. Part 2d.
p. 305.

is the character which marks the presence of the magnesian earth.

Flexibility and Elasticity of Dolomite.

In the Borgheze palace at Rome, there is a slab of dolomite, which possesses a very considerable degree of elasticity and flexibility, and Mr Fleuriau de Belvue has discovered a nearly similar stone at Mount St Gothard in Switzerland *. He observed that all the specimens which possessed this property, were to be obtained only from the outside of the strata, and in the parts which had been most exposed to the weather. This circumstance led him, along with Mr Dolomieu, to suppose, that its peculiar properties were owing to the separation of a part of its water, which thus weakened the adhesion, and probably altered in a small degree the arrangement of the integral molecules. He confirmed this idea, by exposing Carrara marble, gypsum, and other inflexible stones to a low degree of heat, by which they acquired a considerable degree of elasticity and flexibility. He found, however, that it was only those marbles that had a crystalline grain, and contained little iron or argill, that could be made flexible and elastic.

As the dolomite of I-columb-kill agrees in many of its properties with that from St. Gothard, it deserves to be tried whether it will become flexible and elastic, by treating it as directed by Mr Fleuriau de Belvue. His process is very simple: he puts a thin slab of the marble into a sand bath, and keeps it at the temperature of 30° of Reaumur for an hour and a half, or, if it be a pretty large slab, for a considerably longer time. He then removes it, and allows it to cool, and even to absorb a little moisture; and then presses it in all directions, so as to destroy that adherence among the particles which the fire has not affected.

NEPHRITE.

TALCUM NEPHRITICUM, Lin. & Wern. *JADE*, BEILSTEIN, &
BITTERSTEIN, German.

Colour. Yellowish or fiskein-green; olive-green; and sometimes approaching leek-green.

Fracture. Coarse or fine splintery.

Transparency. In pretty thin pieces, it allows objects to be seen through it indistinctly, but is generally more opaque.

Hardness. Sometimes gives fire with steel. In other specimens, is difficultly scraped with a knife.

Feels greasy.

It is dispersed thro' the marble, and is seen passing gradually into it; has sometimes scales of mica mixed; and not unfrequently we observe narrow veins of asbestos traversing it. It is a curious fact, that the pieces we find upon the shore are often harder than those which we break out of the marble.

The only use that is made of it, is for ornamental purposes; but the pieces which have been found in I-columb-kill are generally too small for any fine work. In Turkey it is wrought into very elegant handles for daggers and scimitars; and La Metherie remarks that the many fine pieces in oriental nephrite may have been made before it acquired its present hardness, which, he supposes, was produced by exposure to a gentle heat †. Some of the pieces which have been found in Iona are extremely beautiful; and there can be no doubt that, were it quarried on purpose, many magnificent specimens might be obtained.

BA-

† Theorie de la Terre, tom. 2.

BASALT COLUMNS *of Staffa.*

Several years ago, Mr St. Fond analysed this basalt, and found it to contain, in the hundred parts—filex 40, argil 20, lime 12, magnesia 5, iron 21. More lately, Dr Kennedy of Edinburgh has repeated this analysis, and found nearly similar ingredients; with the difference, that he always obtained a small portion of soda and muriatic acid. According to his trials, 100 parts contain—filex 48, argil 16, oxyd of iron 16, lime 9, moisture and other volatile matter 5, soda about 4, and muriatic acid about 1.

COLL AND TIRIE.

C H A P. XVIII.

Outline of the MINERALOGY of COLL and TIRIE.

HAVING examined as much of the islands of Mull and I-columb-kill as our time would permit, we took leave of the worthy family of Torloisk, and walked to the harbour of Quines, which is situated upon the north-west part of Mull. Here we luckily found a boat about to sail for Coll, an opportunity which we gladly embraced; and, after a tedious passage of ten hours, we landed at the seat of Colonel Maclean, where we were most politely received.

COLL.

C O L L.

THIS island is about fourteen miles long, and two miles broad. It is low, rugged and bleak; but in some places there are beautiful flats, which, during the summer, being cultivated, or adorned with wild flowers, form a striking contrast with the weather-beaten rocks which skirt them. The shore, upon the east side, is generally low and rocky; on the west, it rises into considerable cliffs, and, in many places of this side, great sandbanks extend for a considerable way. These banks are often of considerable height, and form groupes of sandhills; which are sometimes covered with the *Arundo arenaria*, *Galium verum*, &c.; but more frequently they present only a dreary waste: for, during storms of wind, the sand rises in clouds, to overwhelm and destroy the neighbouring country. The inhabitants have themselves partly to blame for the continuance of this evil, by their obstinacy in rooting up certain plants which prevent the blowing of the sand: thus, it is a common practice to use the *Arundo arenaria* as a substitute for ropes, and the *Galium verum* as a yellow dye; two plants which are very remarkable

markable for their power in binding the sand. Colonel Maclean has prohibited this very pernicious practice, by severe penalties; which, it is hoped, will have the desired effect.

MINERALOGY. At the Loch, where is situated the seat of Col. Maclean, the island is low; but upon the E. and W. great sand-banks appear. The loch is small, rocky and shallow; so that, in stormy weather, it can afford very little shelter for vessels. If we proceed along the south part of the island, towards Loch Alin, considerable sandy beaches present themselves; but they are now and then interrupted by tracks of gneiss. This gneiss is traversed, in several places, by great veins of granite. The granite, which fills these fissures, is easily distinguishable from that which is deposited in strata, by the great size of its constituent parts. Dolomieu, during his travels, often observed granite in veins, which, he remarks, is easily distinguished from that which forms strata; and Mr Besson also informs us, that the granite veins of Limousin are distinguished from those in strata by the great size of the felspar and quartz. This is not, however, always the case; for Mr Charpentier has mentioned veins of small-grained granite which he saw in Saxony †, and I have observed similar appearances in the Highlands of Scotland.

† Charpentier, Mineralogische Geographie der Chursächsischen lande, § 261, 270.

Scotland. At Loch-Alin, Col. Maclean showed us a small vein of Galena, about three inches wide, traversing the gneiss and sienite strata; but it was so near the shore, that we had not an opportunity of tracing it but for a short way. Such an appearance, however, deserves farther investigation, when we consider, first, that veins of ore, altho' very trifling at the surface of the earth, increase much as they descend, which is the case with the rich mines of Freyberg and Franconia; secondly, that the rock, in which this vein runs, is, in other countries, extremely productive of rich ores; thus we know that the greater part of the Saxon, Bohemian and Saltzburg mines are situated in mountains of gneiss. Near to this mineral appearance, I observed several veins of basalt traversing the gneiss; and one of them seemed to run nearly in the same direction with the strata: thus intimating that a rent had been formed in the same direction with the strata, or that this basaltic matter really forms a stratum which has been deposited along with the gneiss; of course, it ought to be considered as of primitive formation.

As we continued our journey around the island, I observed the gneiss strata interrupted by a small extent of quartz rock, which contained beautiful crystals of actynolite. This was again succeeded by strata of gneiss, which, in some places, form hills, that are often covered with immense loose masses, broken

from the strata by the power of the weather. Upon examining these masses, I observed them sometimes resting upon smaller pieces, as if they had been raised by the hand of art; but a more close examination showed us, that the smaller masses were the more solid parts of the gneiss, that still resisted the influence of the weather. This fact will explain many of the curious appearances called Rocking Stones, which antiquaries have been often pleased to consider as proofs of the early knowledge of our ancestors in powerful machinery. This gneiss continues to the farm of Knock; but it is now and then to be observed alternating with micaceous schistus and hornblende slate, and frequently all these strata are traversed with basalt veins. The hornblende, in some places of this track, but particularly at Grissopool, is most beautifully crystallized; so that, with very little trouble, magnificent specimens may be procured. At Knock, the gneiss is much traversed with basalt veins, which are of various sizes; some not exceeding a quarter of an inch in width, while others are more than three feet. The gneiss here contains a very great proportion of a red-coloured felspar; and the quartz has sometimes a skin-green colour, similar to that which we observed in the island of I-columb-kill. From Knock to the northern extremity of the island, gneiss, hornblende rock and micaceous schistus are the principal rocks which

which occur; and from the north point, all along the east side, to Colonel Maclean's house, the same strata continue.

In some places of the interior of the island, I observed considerable cliffs of quartz, which is either massive or granular, resembling that from the island of Jura*; but I had not an opportunity to determine its situation with regard to the gneiss, or the other primitive rocks of which the island is composed.

D 2

TIRIE.

* Mr Fleurian de Belvue, as I have before mentioned, having found that different species of marble, by being heated, acquired a considerable degree of flexibility and elasticity; also made a series of experiments on different kinds of sandstone and granular quartz. He found that several of them, by being made repeatedly red-hot, and then plunged into water, acquired a remarkable degree of flexibility; and that some kinds of granular quartz became even as flexible as the famous elastic stone which was brought from the Brazils. The granular quartz of Coll is quite the same with that which Mr Belvue used for his experiments; and there is no doubt that, if it be tried, it will acquire the same curious property.

TIRIE.

THIS island, which is separated from Coll by a narrow sound, is about eleven miles long, and two miles and a half broad. It has many sand-banks, like those in Coll, which are also very destructive. There are a few hills, which are from two to three hundred feet high; but the greater part of the island is low, with interspersed rocks, and numerous small lakes. This island, when viewed from an eminence, appears altogether sterile and waste; yet the quantity of arable land among the rocks is said to equal half the extent of the island: a proportion vastly greater than that of Coll. In the middle of the island there is a large and very beautiful plain, which contains 1200 Scotch acres, and is elevated about six feet only above high-water mark. During stormy weather, the sea not unoften meets across this plain, and is productive of bad consequences. The inhabitants have endeavoured to avert this evil by building a defence of stone and earth on the one side, while the sea, on the other, has raised a considerable barrier of boulder stones: yet neither have been sufficient to resist the waves of the Atlantic.

This

This island appears to have been formerly joined to the island of Coll; the isle of Guna, which lies in the sound, being apparently part of the intermediate land, which has escaped destruction. On this account, there is but little difference in their composition; the greater part of Tirie being formed of strata of hornblende rock, gneiss and sienite, which are in general very much elevated. These strata are, in different parts of the island, traversed with veins of basalt; and, at the south-west part of the island, I observed a great quartz vein, interspersed with iron pyrites, traversing these strata; and also a great vein of compact arenaceous quartz, which is intermixed with leaves of talc, crystals of felspar, and a few pieces of galena. Probably this vein, upon trial, might afford lead ore in such quantity as to be worthy of working. It would be of little consequence to enter into a detail of the slight alterations of the strata in particular parts of the island; I shall therefore terminate my few observations, by giving a short account of the marble quarry, which has rendered this island so remarkable.

The marble quarry is situated immediately upon the sea-shore, at a farm called Belephetrich: here the shore is low and rocky; but at a little distance there is an eminence, called the Hill of Belephetrich. The strata are nearly vertical; and are composed of hornblende rock, and a compound of deep-red coloured

coloured felspar and quartz, which has sometimes crystals of hornblende interspersed. The marble forms a stratum of very considerable extent; it appears also to be nearly vertical, and is bounded by the rocks we have just mentioned. It is crossed in some places by small veins of quartz and reddish-coloured hornstone; and I observed a vein of granite, composed of felspar and quartz, traversing it. This stratum of marble has been considered by several travellers as a vein; but I apprehend this is a mistake. In other countries we find marble in a similar situation: thus Voight* informs us that it has been observed between hornblende slate and sienite, and even that it has been found between granite in Sweden †.

Upon the opposite side of the hill of Belephetrich, there is a stratum of white marble, which is situated among the usual rocks which compose the island. This stratum seems also to have been quarried, but, like the other, is long since given up as unprofitable.

AS

* Voight, Prack. 48. † Ibid. Briefe ueber der gebergslehre, § 12.

AS I have to describe particularly only two fossils belonging to these islands, it would be unnecessary to throw them into a distinct chapter: I shall therefore insert the descriptions in this place.

Red-coloured MARBLE—*Belephetrich.*

Colour. Pale blood-red, light flesh-red, and reddish-white.

Lustre. None, except from a number of dispersed shining foliæ.

Fracture. Fine splintery.

Transparency. Transmits light freely at the edges.

Hardness. Yields pretty easily to the knife.

There are dispersed through it,

1. *Hornblende.* The crystals are of various sizes, from the tenth of an inch to three inches long; and they vary somewhat in the intensity of the green colour. It is mixed in different proportions

proportions with the marble: so as to produce pale blackish-green, dark asparagus-green, and a colour approaching to leek-green. Transparent sea-green calcareous particles are frequently to be observed intermixed with the hornblende, and also beautiful, but very minute garnets.

2. *Mica*—Is sometimes in pretty large plates; is of a yellow, tombac brown, or green colour; and appears passing to schiller spar.

White MARBLE—*Belephetrick*.

Colour. White, or very light blue.

Lustre. Pretty considerable, from the foliæ.

Fracture. Granularly foliated.

Transparency. Transmits light at the edges.

Hardness. Yields with difficulty to the knife.

There are dispersed through it scales of mica and crystals of hornblende. When the hornblende is minutely diffused, it gives the marble a green, or yellowish-green colour: then it has a splintery fracture, with little lustre, and increased hardness. Sometimes the hornblende seems to be very intimately combined

combined with the marble; when it forms those beautiful yellowish green spots, which have made this variety of the Tirie marble to be so much admired. These yellow spots have been reckoned by some mineralogists as the same with the spargelstein of Werner.

CORUNDUM, or ADAMANTINE SPAR, of Tirie.

The Honourable Mr Greville, in his memoir on the adamantine spar, observes—"I had observed, in the specimens which Mr Raspe called Jade, or a new substance from Tirie, on the west coast of Scotland, a great resemblance to corundum: but having then had only a cursory view of the substance, I am indebted to Mr Hatchett for the examination of a specimen of it, which he had from Mr Raspe's collection. The Tirie stone resembles crystallized corundum of the coast ‡, in texture and colour: it is also as refractory, when examined by the blow-pipe, with different fluxes. Its specific gravity is 3.049; consequently nearer the specific gravity of pure corundum than the above mentioned lump 2.785, and the matrix of corundum 2.768. The Tirie stone will scratch glass readily, but not rock crystal: its hardness, therefore, corresponds with that

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of

‡ Coast of Coromandel.

of the corundum *." I believe there are specimens of this corundum in the Museum of the University; and of these I shall probably communicate an account at the close of this volume.

E I G G.

*Philosophical Transactions of the Royal Society of London, 1798, p. 49.

EIGG, RUME AND CANNA.

C H A P. XIX.

Outline of the MINERALOGY of EIGG, RUME and CANNA.

HAVING thus taken a general view of the islands of Coll and Tirie, we left with regret the hospitable family of Coll, whose numerous and polite attentions had rendered our stay in this island so agreeable.

We failed from the bay immediately below Col. Maclean's house, and, after a voyage of five hours, we landed upon the island of Eigg, and walked to Mr Macasgill's, who, we found, was at that time on the mainland; yet, during our stay in this island, we experienced every attention from his family.

E I G G.

THIS island is the property of John Macdonald, Esq. of Clanranald, is between four and five miles long, and from two to three miles broad. It is hilly; the principally flat and cultivated piece of country being confined to the shore opposite the mountainous isle of Rume.

MINERALOGY. The harbour upon the south-east extremity of the island, where we land in coming from Coll, is formed by a small isle, called Eillean-Chastell, which is composed of basaltic rocks. The shore, immediately opposite to this isle, is high; and the cliffs are split into pretty regular basaltic pillars, which are of considerable size. As we proceed towards the east side, the shore becomes lower; but this is only for a short way, as it soon rises again upon the east coast, forming cliffs of vast height. These stupendous precipices extend all along the east and north part of the island; forming many wild and romantic scenes, and affording several distinct views of the disposition of the strata. The strata are nearly horizontal; and are, in some places, so well exposed, that we can observe their
alternation

alternation from the level of the sea to the summit of the cliffs. I shall therefore, in describing them, begin with the lowermost stratum, which is,

1. *Shistose Clay*. This stratum is a few inches thick; and is composed of a dark-coloured shistose clay, which contains numerous well-preserved shells apparently of the genus tellina.

2. *Compact Limestone*. This forms a thin stratum, lying immediately upon the shistose clay.

3. *Shistose Clay*. This stratum is about ten inches thick, and rests upon the limestone.

4. *Compact blue Limestone, containing shells*. This stratum is about ten inches thick, and rests upon the shistose clay. It acquires a yellow colour by decomposition; so that it is well distinguished from the other strata, even at a distance.

5. *Shistose Clay*. This rests on the limestone.

6. *Basalt*. The covering of grass prevented me from discovering the basalt in immediate contact with the clay; yet, from its vicinity, it is very probable that it covers it.

7. *Fi-*

7. *Fibrous Limestone.* The stratum of basalt is covered by a thin layer of this species of limestone, which has a blackish colour from mixed bituminous matter.

8. *Basalt.* This covers the limestone.

9. *Argillaceous Sandstone.* An immense stratum of this sandstone lies upon the basalt. It is in general soft, but we were told that sometimes it is very hard. This harder kind is probably got by blasting, as the interior of sandstone rocks, as Charpentier * observes, is the hardest; or it may be other harder sandstone strata alternating with the softer, as I have observed in the Orkney Islands and other parts of Scotland.—This sandstone frequently contains impressions of shells; and it alternates with strata of basalt, which are from four inches to several feet thick. This alternation renders it very probable that the basalt may also contain similar animal remains; and this conjecture is rendered the more probable from several facts which have been lately discovered. Thus Mr Kirwan informs us that Dr Richardson had discovered shells in the basalt of Ballycastle †; Bruckenman has observed muscle shells, ammonites

* Charpentier, Mineralogische Geographie der Chursächsischen lande, 44.

† Kirwan's Geological Essays, p. 252.

nites and corallites in the basalt of the pretended extinct volcanoes of France †; and impressions of leaves have been observed in basalt, as related by Lenz ‡.

10. *Basalt in columns.* This forms a great stratum, which covers the argillaceous sandstone. The columns are varied, not only in their size, and in the number of their sides, but also in their direction being perpendicular, horizontal, or bent, like those of Staffa. The bent columns are generally smaller in their dimensions than those that are perpendicular or horizontal.

11. *Wacken.* This forms an immense stratum, which we observe resting upon the basalt columns. It frequently contains beautiful crystallizations of zeolite.

12. *Red-coloured Wacken.* This stratum is only a few inches thick, and it rests upon the wacken. It is perfectly similar to that which we observed in Mull.

13. *Basalt.* This forms a great bed, which lies on the red-coloured wacken, or, when it is a-wanting, on the common wacken.

These

† 1 Chym. Ann. 1794. § 103, &c.

‡ Lenz. 374.

These strata are traversed in several places by veins of basalt; which do not appear, in any instance, so far as I have examined, to have occasioned any alteration in their direction or hardness.

Nearly at the northern extremity of the island, the cliffs, we have now been describing, turn inwards, and run in a semicircular form, until they again appear upon the coast on the west side of the island. The semicircular track, included by these cliffs, is pretty flat, of considerable extent; and the cliffs, which bound it, are composed of strata similar to those on the east and north sides of the island. The bottom, in such places as I examined, is composed of strata of limestone containing shells, alternating with shistose clay, and sometimes resting on basalt or sandstone. Upon the south side of this track the sandstone and limestone disappear, and now basalt and wacken form lofty precipices. Immediately at the bottom of these basaltic rocks, upon the sea-shore, I picked up several pieces of black pitchstone, much resembling that found in the islands of Arran and Mull; but I could not discover whether it forms veins or strata. From this to within a mile of Eillean-Chastil, the island is bounded in many places by lofty precipices: and the interior is formed of irregularly-shaped,

shaped, grey-coloured, columnar hills, and, among these, Scure-Eigg, which is the highest, has a very singular appearance.

In the sea cliffs there are several considerable caves. They are generally situated in a wacken which is traversed by basalt veins. This wacken contains most elegant specimens of capillary zeolite, also calcareous spar, quartz crystals, and chalcodony; and in several places I observed a red-coloured wacken similar to that which is described at p. 235, vol. i. Several of these caves are of considerable extent, and are open to day; others are narrow at their entrance, but enlarge considerably as we go inwards.

The minister of this parish, who was so good as to accompany us to several parts of the island, led us, by a very rugged path, to a wild sequestered spot, where there is a cave, remarkable, in the annals of this isle, for the murder of the Macdonalds, inhabitants of Eigg, by the Macleods of Skye. As this story is truly characteristic of the state of society in those parts at that period, I think it will not be uninteresting to relate it shortly.

A party of the Macleods having landed upon the small island of Eillan-Chastel, behaved so outrageously to the women who

were there tending cattle, that their friends instantly pursued, and put several of them to death. This so enraged the clan of Macleod, that they determined to take revenge, by ravaging the isle, and putting to death the murderers of their brothers. The islanders, sensible of their weakness, prepared to shelter themselves, upon the first appearance of an enemy. Soon afterwards a number of boats were seen approaching the isle; when the trembling inhabitants retired, in despair, to this cave, their only refuge. The Macleods soon landed, and traversed the whole island; but, as they could discover no human being, they concluded that the Macdonalds had made their escape to the mainland, or to some of the adjacent islands. Disappointed and enraged, they were about to leave Eigg, to return to Skye, when unfortunately one of the horde observed the mark of footsteps on the snow, and thus they were enabled to discover the cave where the wretched inhabitants had taken refuge. Shrieks of despair were interrupted for a little, by a proposal of the Macleods, that if the murderers were given up to punishment, the other lives should be spared. This was only a cruel aggravation of their sufferings, as the Macleods were the aggressors. Connected, as the Macdonalds were, by the dearest ties, they determined to perish together, rather than to give up one of their number. The Macleods, with the most savage barbarity, instantly

instantly kindled great fires at the mouth of the cave, which soon suffocated the whole of the miserable inhabitants.

One often listens even to such a tale, as to the description of a battle, without much interest: but the view of the scene never fails to awaken a keener sympathy—the circumstances are brought nearer to the mind, and seem to be passing before us. We stood on the very ground where this tragedy was acted, and felt our sensibility increased by the sequestered and dreary place in which the deed was done. But even this interest was faint, when compared to that we felt, when, after creeping for a considerable way through a low and narrow entrance, half covered with brushwood, we found ourselves at last within a large and gloomy cave, the extent and height of which we could not distinguish; and perceived the gleams of the lights we carried reflected from the bones and skulls of the unhappy Macdonalds. The force with which the truth and all the circumstances of this dreadful tale struck at this moment upon our minds, and the strange variety of sensations excited by an event so extraordinary, it is not easy to find words to express.

The entrance of the cave is low and narrow, for about 12 feet. The cave itself extends to a height of 22 feet, the breadth 24 feet, and in length it extends inwards nearly 213 feet. The air was damp and raw. Our lights struck faintly on the black

sides of the caves, without dispelling that deep and solemn gloom, which harmonised so well with its melancholy story. The projecting masses of the rock were dimly illuminated, while the skulls and scattered bones caught a strong light. Our figures, too, touched with the pale flame, showed the features, or an outstretched arm, while the parts of the body removed from the light were lost in the gloom. Even the deep and sonorous voice of the parson had its effect. The whole scene was admirably adapted for the canvas: but it would require a very rare talent in the painter who should attempt it.

A short way from this cave, after walking over rocks of basalt and wacken, I observed on the shore two veins of black pitchstone. These veins are about ten feet distant from each other, are from half a foot to three feet wide, and are a little bent in their course. They run in a species of basalt, which contains a considerable portion of zeolite, and in some places small layers of chalcedony. The pitchstone and basalt are sometimes intermixed at their junction, and even pieces of the pitchstone appear immersed in the basalt. But the most remarkable circumstance attending this pitchstone, is the intermixture of one of the veins with a vein of hornstone. This ap-

pearance



PITCHSTONE and HORNSTONE veins
traversing BASALT. ISLAND EIGG.

pearance is represented in the plate*, where A is the basaltic rock in which the veins run; B is the vein of pitchstone, and C is the hornstone vein. The vein of hornstone, at D, is about two and a half feet wide; but it varies much in this respect, as it shoots through the pitchstone. At F, the hornstone has inclosed a wedge-shaped piece of pitchstone. At G H there are two stripes of hornstone, one of them, G, containing a thin piece of pitchstone.

These appearances may be explained, by supposing, that, after the vein of pitchstone had been formed, new rents extended both through it and the basalt, and that these were afterwards filled with hornstone. The pieces of pitchstone inclosed in the hornstone, appear to have been broken off the pitchstone vein, and at the time when it was rent, and were afterwards surrounded by hornstone.

Altho' pitchstone has been discovered in various parts of Europe, it has not been before described as belonging to the rocks of trap formation. Haquet, indeed, mentions, that he observed basalt columns converted into glass, among the basalt of the

Ve-

* It must be understood that the plate represents a horizontal section of the pitchstone and hornstone veins.

Veronese. This is very probably pitchstone; yet we cannot say so with certainty, as the appearance is not described with sufficient exactness. Obsidian, however, which, as we have before observed, is nearly allied to pitchstone, has been lately observed by Humboldt, stratified with basalt, at the top of the peak of Teneriff.

We now ascended from this to the Scure Eigg, which we have before observed to be the highest part of the island. This hill, from its peculiar shape, has, at a distance, a singular appearance; but as we approach nearer, it rises much in grandeur, and at length, a stupendous columnar promontory bursts on our view. The whole of this promontory is perfectly mural, and extends for upwards of a mile and a half, and rises to the height of several hundred feet. It is entirely columnar, and the columns rise in successive ranges until they reach the summit, where, from their great height, they appear diminutive. Staffa, which is the most magnificent assemblage of natural columns that has yet been discovered, is the only one that can bear a comparison with Scure Eigg. Staffa is an object of the greatest beauty and regularity; the pillars are as distinct as if they had been raised by the hand of art; yet it has not the extent or sublimity of Scure Eigg: the one may be compar-

ed



Engr'd by R. Scott & Son

Columnar Promontory of Saint-Eugene

ed with the greatest exertion of human power; the other is characteristic of the wildest, and most inimitable works of nature.

The columns are disposed in different directions, being either perpendicular, curved, or horizontal. Sometimes we observe the horizontal pillars crossing each other; the sides of the horizontal columns appearing above and below the ends of those horizontal columns which lie in a contrary direction. They vary considerably in the number of their sides, having three, four, five, six, and seven sides; but I did not observe any of them jointed. I conjectured, at first, from the nature of the strata of which the island is composed, that these columns were basalt; but a nearer examination showed that they were formed of a species of porphyry, with a basis intermediate between basalt and pitchstone. The same kind of porphyry seems to form many of the other hills in the interior of the island.

RUME.

R U M E.

AS the voyage from Eigg to Rume is rather dangerous, on account of the terrible squalls of wind which often blow from the high lands, we did not prolong our stay, after we had made the few observations which have been just mentioned. We therefore sailed from the west side of the isle of Eigg, and, after a pleasant sail, we landed at Kinloch, at the head of Loch Skrefert in Rume. Here we had our exertions assisted by Col. Maclean's officer, and the other people of the island, who manifested every wish to serve us.

DESCRIPTION. This island, which is the property of Col. Maclean of Coll, is about eight miles long, and nearly as broad. It lies between the isles of Eigg and Canna, and is about seven miles NNW, from Eigg, and four from Canna. It is altogether mountainous; in short, it may be reckoned a groupe of mountains, of which, Aisgobhall is the highest. Its shores are in general very bold and rocky, and often present tremendous perpendicular precipices.

Loch-

Loch-ikrefort, which is the only harbour in the island, is about two miles long, and is bounded upon both sides by hills of considerable height, which rise pretty rapidly from the sides of the loch. The strata upon both sides are of red-coloured sandstone. At Kinloch, the small village at the head of the loch, the land is low and continues pretty much so, to the shore opposite to the island of Canna, forming a kind of valley which is bounded by lofty hills, which are more rugged upon the south than the north side. The bottom of this valley is elevated in the middle; and here we observe another valley which runs quite in a contrary direction. The hills upon the north side of this valley are composed of red-coloured sandstone, which is elevated at an angle of 12° ; and it is also stratified with basalt, and traversed by basalt veins. These veins are even to be observed bursting out upon the top of the hills; and often the basalt, in these veins has a remarkable power over the compass: detached pieces act very powerfully. The sandstone by decomposition assumes various tints, as red, purple, white, &c. and often it also decomposes in flates; and these are frequently curved. Upon the shores, masses of onyx and sardonix are to be observed; probably coming from the sandstone or basalt.

As the mountains upon the south side of the loch are much higher than those upon the north, and their shape and general appearance considerably different, we agreed to ascend one of them, so that we might become acquainted with the rocks of which it is formed. Accordingly, we began to ascend the mountain called Halival, which rises immediately from Kinloch, but found it fatiguing not only on account of the wetness of the ground, but also from the many hollows into which we frequently tumbled, owing to their being concealed by long heather. Having reached the first shoulder of the hill, we found an extensive platform, which is formed of basalt and greenstone; and the sandstone which had continued from the bottom of the hill, does not go higher than this. Above this platform, the appearance of the hill is much altered, the heather disappearing, the side of the hill being covered with grey stones, and appearing to rise by a succession of platforms or terraces. We now clambered upwards over a wilderness of stones of greenstone and basalt, until we were about 60 feet from the summit. Our further progress seemed now to be stopped, as the mountain appeared to be surrounded by large blocks of greenstone standing in an almost perpendicular direction. Our guide, however, conducted us to the summit by a steep path, which was not without danger. Unluckily, a few minutes before we reached the summit, it was enveloped in clouds, so that

that it was only as they cleared away, that the mountain of Aisgobhall was to be observed towering above us ; and by its terraced aspect, announcing a similitude of composition with that on which we were standing. At some distance several other hills appeared with terrible, bare, rugged, intervening glens ; and all apparently composed of trap-formation rocks. As we were resting upon the summit, I picked up specimens of a dark green-coloured crystallised pitchstone ; but I did not discover it *in situ* : near to the same places, I observed several pieces of a rock resembling the Lydian stone which seemed to traverse the greenstone in the form of veins. As the clouds were now spreading all around, we found it necessary to descend ; but we took a different rout, so that we might see as much variety of rock as possible. We did not, however, meet with any fossil differing from what we had seen in the ascent ; and the disposition of the strata appeared to be the same, viz. greenstone and basalt forming the higher parts, and red sandstone the lower. From the slight examination of this mountain, and the general appearance of the others in the neighbourhood, it is probable that all the south side of the valley is formed of sandstone in the lower parts, and the upper of rocks of trap formation.

I cannot omit mentioning a curious appearance which I observed, in examining a ravine upon the south side of the valley,

where it was said coal had been found. Immersed in the basalt, which forms part of these hills, I discovered pieces of limestone, (with interspersed bituminous matter,) from 4 to 12 inches long, and 2 inches in diameter. In the Philosophical Transactions of the Royal Society of London for 1796, we have the account of a nearly similar appearance observed in the works of the Huddersfield canal. In perforating a hill by a subterraneous tunnel, the workmen met with a fault or break in the strata through which they were cutting, when they found a rib of limestone, and a number of pyritical limestone balls, from one ounce to upwards of 100 lb. weight. No limestone had been discovered in that country nearer than 20 miles. In Rume, so far as I could learn, there is not any strata of limestone: a circumstance which may possibly render the explanation of these phenomena a little difficult.

As circumstances did not allow us to spend more time in this island, we left Kinloch, and, after a rugged walk during a violent storm, we reached the shore of the island opposite Canna. Here we found a most magnificent, bold, broken coast, formed of strata of red-coloured sandstone, which are elevated at a considerable angle, and alternate with basalt, and are also traversed with numerous veins of basalt.

Besides

Besides these appearances, I observed, as we were walking along the shore, waiting until the storm should allow us to cross to Canna, vast strata, apparently of basalt, or wacken, lying on the sandstone, at the summit of the tremendous cliffs which here bound the island. I now regret extremely that the inclemency of the weather prevented me from examining these strata; for unquestionably they would have proved highly interesting, if we may judge from the specimens that had tumbled from them upon the beach. The following are a few of the fossils which I picked up on the shore.

1. Green, or yellowish-green coloured heliotrope *, which adhered to masses of basalt ‡, or forming little balls immersed in it.

2. Basalt, containing rounded balls of green earth, along with similarly-shaped masses of calcareous spar.

3. Basalt,

* This heliotrope is sometimes so soft, that it has a good deal the appearance of pitchstone.—Is this owing to its being altered a little by the action of the weather?

‡ From the specimens being a good deal decomposed, I cannot say with certainty whether this is to be considered as a basalt or a wacken: I at present rather think it is a basalt.

3. Bafalt, containing chalcedony : and this chalcedony is frequently penetrated with the green-coloured heliotrope, forming a stone that seems to be the plafma of the Italians.

4. Bafalt, with whitish, or light-brown coloured hornstone, which has fometimes an apple-green colour, from its being penetrated with heliotrope.

5. Maffes of hornstone, which contain beautiful quartz cryftals.

6. Chalcedony in ftalactites ; and, what is remarkable, pieces of the ftalactites are obferved lying in, and furrounded by calcareous fpar.

7. Beautiful maffes of onyx, which are, in fome specimens, covered with a white cruft.

The weather having now become a little more moderate, we croffed the found to Canna, thro' a very tremendous fea.

CANNA.

C A N N A.

THIS island, the property of John Macdonald, Esq. of Clanranald, is about five miles long, and two miles broad. It is low; but its shores are bounded by steep and lofty cliffs. It is remarkable for its harbour, which is reckoned one of the best among the Hebrides: yet it is difficult of approach in stormy weather, owing to the narrowness of the entrance, and the funk rocks that lie near it. This harbour is formed, upon the N. by Sand island, which is separated from Canna by a strait, which is left nearly dry at every ebbing of the tide. The island is low, and consists of rocks of trap formation. The end, which forms the entrance of the harbour, is of basalt tuff, having basalt pillars resting upon it. The opposite side of the harbour is formed by the island of Canna, which is here of considerable height, and rising by beautiful and regular terraces. These terraced appearances, which are in general pretty sure marks of a basalt country, do not here deceive us, as the rocks are decidedly basaltic, and in several places are split into columns.

In

In examining this island, we walked along the shore towards the W. which we found low and rocky, but bounded by considerable land-cliffs of columnar basalt. This basalt, in some places, rests upon basalt tuff; but, farther on, I observed the tuff exposed without any covering—the basalt, if it had ever been super-imposed, being washed away; and, near to the place, the basalt pillars are seen wore down by the action of the sea, the ends standing up under the water like a regular pavement. At a place called Tarbet, the cliffs on the shore assume a bold form: they there rise to a great height, and are immediately washed by the sea, or, in other places where there is an accumulation of debris, the further action of the waves is prevented. The superior stratum of these cliffs is columnar basalt. The pillars vary very much, not only in size, but also in the number of sides; and frequently they are to be seen bent, when their length and breadth is less than the upright ones. Immediately below the stratum of basalt, there is a stratum of wacken, which contains calcareous spar, elegant capillary zeolite, quartz crystals, blackish-coloured crystals, whose nature I am ignorant of, and, more rarely, crystals of leucit, or Vesuvian garnet. To this succeeds another stratum of basalt; and below it, a stratum of wacken; and so on, alternately, to the bottom of the cliffs.

Having

Having walked for a considerable way along a narrow path in the face of these cliffs, the violent wind and rain forced us to scramble to the summit, as it was impossible to walk longer in this track, without the risk of being precipitated into the sea, or among the rocks. We now crossed the island to a place called Dun-eudain, where coal had been formerly wrought: unluckily the cliff had fallen down, so that I had not an opportunity of seeing it. We were told, by the people who had worked it, that it was a stratum from 6 to 8 eight inches thick, and was inclosed in whin rock (basalt or wacken). Its situation, upon the face of a high cliff, was given as the reason why the working was stopped: this is a circumstance, however, of little detriment; for, if the coal stratum had been of considerable extent, many economical expedients might have been used to raise the coal. From this, in going around the other parts of the island, the cliffs become lower; but they soon rise again, and continue of great height nearly to the harbour of Canna. In many places of these cliffs the strata are well exposed: thus, upon the east side, near to Compass-Hill, the uppermost stratum is basalt, with a slight tendency to the columnar form; below this, is a stratum of basalt tuff; this is again succeeded by basalt; and so on, alternately, to the bottom of the cliffs. The shore is covered with a vast collection of debris from the cliffs; and, in some places,

it even seems to form a kind of alluvial breccia, in which vast masses of columnar basalt are immersed.

Compass-Hill, which we have already mentioned, is situated at the top of the cliffs we have been just describing; and appears, at its summit, to be formed of a species of basalt, which, by decomposition, acquires the power of affecting the compass: hence this eminence has received its name. Other rocks in the island, however, are much more powerful in this respect: thus the basalt at the outer point of the harbour affects the compass at the distance of between 25 and 30 feet.

Near to this hill, but immediately upon the shore, there is an isolated rock, called Humbla, which is interesting to the antiquarian, as there is upon its summit the ruin of a small castle, where, it is said, an old jealous highland chieftain, even long ago, vainly endeavoured to confine a handsome wife. At a little distance, there is another rock, where basalt tuff lies on basalt; and, in the tuff, I observed several pieces of wood slightly bituminated. In one place I saw a piece of wood about two feet long, but only a few inches thick: thus intimating that it had acquired its shape either by the pressure of the superincumbent rocks, or by the contraction of the argillaceous

aceous earth of the basalt*. In proof of this latter opinion, which seems the most probable, I may observe, that the carbonated wood found in limestone, or among coal, is never observed to be flattened.

As the appearance of wood, thus slightly altered, in a rock of trap formation, is interesting for geology, I will now shortly mention a few similar appearances which have been observed in other parts of the world. At Stackhouse, in Westerwald, there are strata of carbonized wood, which alternate with wacken and clay†. Mr Esmark observed a vein, at the depth of 200 fathoms, entirely filled with carbonized wood‡. Werner mentions veins of wacken, at Bautzen, that contain pieces of bituminated wood||. Near Rennes, a whole chestnut tree was observed lying horizontally among schistus; of which the bark was converted into pyrites, the sap into jet, but the center was wood slightly altered, being nearly in the state of char-

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coal.

* Kirwan's Geological Essays, p. 46.

† 1 Berl. Beob. 52, 56. Kirwan's Geological Essays, 311.

‡ Neues Bergmannisches Journal.

|| Werner Neue Theorie von der Entstehung der Gänge.

coal *. Mr Pennant informs us that wood is found inclosed in the solid rock in different parts of Iceland, and, like that of Canna, is very much flattened: what is remarkable, pieces of the wood are often found so little altered, and of such a size, as to be easily planed, and made into middle-sized tables †.

* Journal de Physique, Mai, 1786.

† Introduction to Arctic-Zoology, p. lx.

EIGG,

EIGG, RUME AND CANNA.

C H A P. XX.

Description of the FOSSILS mentioned in the preceding Chapter.

Columnar PORPHYRY of Scure-Eigg.

This rock has, dispersed thro' it, numerous crystals of yellowish or white-coloured crystals of felspar; and the basis presents the following characters:

Colour. Black.

Lustre. Little glancing, or rather glimmering.

Fracture. Even, approaching more or less to the conchoidal.

Transparency. None.

Hardness. Gives a few sparks with steel; but sometimes yields also with great difficulty to the knife.

It decomposes into a greyish-white powder.

Fusibility.

Fusibility. At 29° it had acquired a grey or white colour, and was converted into a kind of enamel.

This change by action of the heat, conjoined with the external characters, confirm me in the belief that it is intermediate between pitchstone and basalt.

PITCHSTONE—*Eigg.*

Colour. Deep black, or bluish-black.

Lustre. Pitchy, strong glancing.

Fracture. Uneven; or, even, with a greater or less tendency to the conchoidal; and sometimes *shistose*.

Transparency. None.

Hardness. Scarcely gives fire with steel.

Fusibility. Formed a black cellular mass at 47° , and at 52° was more compact.

There are, interspersed, a few crystals of felspar, and thin layers of a yellow-coloured substance.

HORN-

HORNSTONE, which traverses the Pitchstone—*Eigg.*

Colour. Pale greenish-grey.

Lustre. None.

Fracture. Even, or fine splintery.

Transparency. Hardly perceptible at the edges.

Hardness. Gives fire pretty plentifully with steel.

There is, dispersed thro' it, calcareous spar and chalcedony. The chalcedony is of a bluish-white, or light-yellow colour; and is similar to that which I have mentioned in the preceding chapter, as being contained in the basalt. It is sometimes cellular; and these cells are lined with quartz crystals, and filled with a nearly liquid bitumen.

BASALT, in which the Pitchstone Veins are situated—

Eigg.

Lustre. Little glancing, from a number of minute crystals of hornblende which are dispersed through it.

Fracture. Uneven.

Hardness.

Hardness. Yields with some difficulty to the knife; and leaves a grey trace.

By decomposition it acquires an iron-grey colour.

GREENSTONE—*Rume.*

It is composed of crystals of hornblende and felspar; and, intermixed, there are beautiful transparent grass-green coloured crystals, which resist decomposition, while the felspar and hornblende are reduced to an iron-brown or greyish powder. It has a very great specific gravity.

CrySTALLIZED PITCHSTONE—*Top of Halival, Rume.*

It is of an olive, or dark leek-green colour; and has the usual lustre, transparency and hardness. The crystals are immersed in a rock formed of felspar, with a few scales of tombac-brown coloured mica. They are from the tenth to the half of an inch long; which is much greater than the crystallized pitchstone of Bohemia. I could not discover the form of the crystals, on account of their being much broken; yet I have no doubt that it

is a crystallized pitchstone. As this is a very rare fossil, having been discovered only in another part of Europe, it is well deserving the attention of those who visit Rume.

CHALCEDONY—*Rume.*

This chalcedony is of a bluish-grey, or brownish colour, or even of a milk-white colour, thus approaching to the nature of semiopal; and has the usual lustre, transparency and hardness. It is frequently accompanied by calcareous spar, hornstone, and crystallised quartz. It is also stalactitical; and, what is curious, we sometimes observe fragments of the stalactites inclosed in the calcareous spar*. It is frequently penetrated with

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I.

helio-

*The explanation of the formation of filiceous or chalcedonic stalactites has been considered a difficult problem in geology, and no doubt there is some truth in the opinion. Upon reading with a view of collecting facts on this subject, I met with one which deserves to be generally known, as it will help to explain several of the remarkable forms that the stalactitical chalcedony assumes. Baron Trebra, whilst in the deepest mines at Kromnitz in Hungary, paid particular attention to the appearance of the filiceous stalactites, and observed that those newly formed,

heliotrope, or bloodstone; when it has characters exactly resembling the plasma of the Italians.

PLASMA?—*Rume.*

Colour. Dark apple-green.

Lustre. Glimmering.

Transparency. Sometimes allows the light to pass thro' pretty freely.

Fracture. Even, with a tendency to the flat conchoidal.

Hardness. Does not give fire with steel so readily as chalcidony.

This stone was formerly considered as a species of chalcidony; but Werner has lately described it as a distinct genus.

Abbé The explanation of the formation of siliceous or chalcidonic stones has been considered a difficult problem in geology, and no doubt there is some truth in the opinion. Upon reading with a view of collecting facts on this subject, I met with one which deserves to be generally known, as it will help to explain formed, or forming, in place of breaking, as is the case with the calcareous, were flexible, and this in a very great degree †.

† Mineralien cabinet gesammelt und beschrieben von dem Verfasser der Erfahrungen von innern der gebirge.

Abbé Esthner considers it as an intimate combination of calcedony and talcerde. This may be the case with the specimens he examined; for I have little doubt that chalcedony may, in one instance, be penetrated with heliotrope, and, in the other, with talcerde, yet the resulting fossils may be difficultly distinguishable by their external characters.

Dark apple-green coloured HORNSTONE—*Rume.*

Lustre. None.

Fracture. Coarse splintery.

Transparency. Allows a little light to pass at the edges.

Hardness. Gives sparks very plentifully with steel.

It has brownish-coloured spots dispersed thro' it. This appears to be hornstone penetrated with heliotrope; and the supposition is rendered more probable, from the dispersed brown-coloured spots, which are characteristic of the presence of heliotrope.

HE-

HELIOOTROPE, or, ORIENTAL JASPAR—*Rume*.

CHALCEDONIUS HELIOTROPIUS, Lin. *XANTHUS*, Walker.

Colour. Dark grass-green, or yellowish green; and marked with spherical spots of an iron-brown, or light olive-green colour.

Lustre. Glimmering, with a weak waxy lustre.

Transparency. Very little at the edges.

Hardness. Gives sparks plentifully with steel, but not so much as flint.

The red, olive-green, or iron-brown coloured spots and veins are merely accidental, as the same stone is to be found without them. It is considered by Emmerling as an intimate of green earth and chalcedony; and this is countenanced by its situation in Rume, as both green earth and chalcedony are found accompanying it. A fossil of this name is described by Pliny, at the 10th chapter of the 37th book of his natural history; but its properties are so different from the stone with which we are acquainted, that we must, for the present, consider it as different. It is to be hoped that the intelligent and well-informed Mr Hawkins, who has travelled over so much of the East, where
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it is said the heliotrope of Pliny is found, will clear up this difficulty.

BASALT TUFF—*Canna*.

This rock is composed of rounded masses of basalt, wacken mandelstein, and argillaceous sandstone, connected by a basaltic basis. Very considerable loose masses of sandstone are to be observed in different parts of the island; and seem to be derived from this breccia or basalt tuff: as I did not observe any fixed rock of sandstone in the whole island.

S K Y E.

C H A P. XXI.

Outline of the MINERALOGY of SKYE.

HAVING spent two days in examining what was curious in Canna, we sailed for the island of Skye, and, after a tedious passage, we landed at Rue-dunan, which is about 12 miles from the harbour of Canna.

The island of Skye is about 70 miles long ; but it varies much in breadth, owing to the number of lochs or arms of the sea with which it is intersected. Cambden imagines that it is the eastern Æbudæ of Ptolemy*, while others reckon it the Dumna.

Its

* Ptolem. Geograph. lib. viii.

Its present name is of Norwegian origin, being derived from *Ski*, a mist; and from the clouds that almost perpetually envelope the lofty mountains, it has been styled *Ealand-skianach*, or the cloudy island †. It lies between the mainland of Scotland, and the Long-island; it is, upon the west side, many miles from the Long-island; but on the east, it is separated from the mainland in some places by a sound not half a mile broad. The shores are rocky, and the cliffs in many places are of great height. It is very mountainous upon the SW. where the Cullin mountains rise to a great height, and afford many scenes of the greatest sublimity. To the north of these mountains, the island is formed of comparatively low hills, which continue to within a few miles of the extremity, when they are succeeded by a plain, which forms part of the parish of Kilmuir. South from these mountains, is the low, narrow, parish of Sleat, which forms a peninsula, that is reckoned the most productive part of the island.

CAVES. There are considerable caves that occur in different parts of the island; one at Camesketel, on the south side, is fam'd for having afforded shelter to the unfortunate Prince Charles when he was escaping from Scotland after the battle of

† Dr M'Pherson, in Pennant's Tour.

of Culloden. There are also, in several places, grand cascades ; one in particular, upon the east side of the island, is reckoned little inferior to the fine fall at Fyers, which is between Fort Augustus and Inverness.

LOCHS. This island appears, at some former period, to have been very much exposed to violent convulsions, which have broke up the land, and formed the many lochs which traverse it. The most considerable of these lochs are Snizort, Follart, and Bracadale.

MINERALOGY. Rue-dunan, where we landed, after leaving Canna, is situated at the bottom of the Cullin mountains, and at the head of loch Brittle. The mountains rise here, with the utmost grandeur ; but the continual covering of clouds, prevented me from investigating them with so much accuracy as I wished. I found, that the sides of the loch, and the lower part of these mountains, were composed of basalt ; but the superior parts, appeared to be wholly of sienite and hornblende rock, traversed by basalt veins. The faces of the mountains were bare, steep, and rugged, and were much traversed by open fissures. In some places, I observed the brows of the hills covered with hornblende rock, which, by its brown colour, had

had much the appearance of the serpentine rocks in the island of Unst in Shetland.

Having taken a slight view of these mountains, we intended to proceed to Talysker, as being a central spot for the investigation which we proposed of the coast of Skye, from Ruedunan to Dunvegan-head; but, in this, we were disappointed, as the worthy Col. M'Leod of Talysker, to whose attention we were recommended, died on the very day on which we landed upon the island. We were now glad to take shelter in the first house we came to, and luckily, we met with an obliging man, the shepherd to a gentleman in the army; he lodged us comfortably in his master's almost waste mansion-house; but we soon wearied of this retirement, and set out for Grule, at the head of loch Eynort, where, we were informed, the minister of the parish resided. The path led us through a hilly country, which, as far as I examined, appeared to be composed of basalt and wacken; and both contained fibrous, and variously crystallised zeolite. At Grule, we waited upon Mr Macleod, the minister, to whom we were entire strangers, yet he gave us a most kind reception, and the next day accompanied us near to the valley of Talysker; but we found no variety of rocks, the whole being composed of basalt or wacken; at little Breeze hill, which is near to the vale of Talysker, there is a pretty

colonnade of basalt pillars, which, Mr Pennant, in his voyage to the Hebrides, erroneously mentions as the most northern groupe of columns in Scotland. As the weather was very stormy, we remained with our good host for three days, but on the fourth, our anxiety to proceed on our journey, overcame every obstacle; and we left, with regret, Mr Macleod's hospitable cottage. Upon gaining the upper part of the glen, the rain and mist increased, and prevented us from having a view of many parts of the country. We continued our journey among basaltic hills, until we found ourselves on the side of Loch Harpart, an arm of the sea, which is of considerable extent, and bounded upon both sides by low basaltic hills. From this we walked on to Loch Bracadale, another arm of the sea, in which we observed several small islands, which were all apparently basaltic; as is also the case with the neighbouring country. As the storm had somewhat abated, the remainder of our walk to Dunvegan, the bleak seat of General M'Leod, was not so disagreeable: we, however, observed no variety of strata, as the same basaltic rock still predominated; but at a distance we remarked several truncated hills of considerable height; and two of them, called Macleod's Tables, are said to have a considerable resemblance to Table Mountain at the Cape of Good Hope.—At Dunvegan there is a loch of considerable extent, which is bounded on both sides by low hills, apparently composed

composed of basalt and wacken; and there are dispersed thro' it several small islands, which, from their terraced appearance, seem also basaltic. We were informed that coal had been worked near Dunvegan, but the stratum was so small that it was soon given up. Pieces of wood have been also found in the rocks upon the side of the loch; probably in a breccia resembling that of the rock at the island of Canna.

Although I had no opportunity of examining the rocks upon the shore which extends from Rue-dunan to Dunvegan head; yet, from the basaltic nature of the country near it, and the general appearance of the coast, as seen from the island of Canna, I have little hesitation in saying, that the general rocks will be found basalt and wacken. It is probable, however, that this extent of country may contain many curious sporadic fossils; and veins or strata of pitchstone may also be observed.

We now walked to Kingburgh, by the end of Loch-Bay and Loch-Grifornish, through immense tracks of peat. The neighbouring hills are low; but the rocks upon the sides, and at the mouth of the lochs, are often of great height, and very rugged and broken. I saw no variety of fossils; the whole country, so far as the peat and heather would allow me to examine, being of basalt and wacken.

We remained at Kingsburgh for some days, waiting the return of Mr Campbell, who had gone upon a fishing expedition; but in the meantime I examined the neighbouring country. It proved to be little interesting, as it was entirely formed of strata of basalt and wacken, which contained beautiful fibrous and crystallised zeolite, and both kinds of strata were frequently traversed by basalt veins. The old house, in which Mr Campbell at this time lodged, is remarkable for having afforded shelter to Prince Charles, when pursued by the king's troops; and the shore is noted in history as the place where King James V. landed when he was making the tour of his kingdom. Mr Campbell having returned, we got the necessary instructions for our route to the north part of the island, for which we set off next day. After leaving Kingsburgh, we walked for a mile or two along the side of Loch-Snizort, through a basalt country, until we reached the mill which is situated upon a stream of water at the head of Loch-Uig. A considerable way above this mill there is a pretty large cascade, formed by the water which collects from the neighbouring basaltic hills; and near it we observed appearances of coal. The first was upon the side of the stream in the face of a steep rock: the coal was only a few inches thick, and covered by a stratum of basalt at least 30 feet high. Immediately at the side of the cascade there is another small stratum of coal, a few inches thick, and lying in the
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the basalt. These seams, or strata, however, are so ill-situated, and so trifling, as to be unworthy of any consideration in an economical point of view. Near to the cascade there is a considerable stratum of wacken, which is covered by basalt, and traversed by basaltic veins: it contains nodules and stratulæ of steatites, or soap-rock.

After crossing this stream, we came to a good road, which led us to the top of a basalt hill; and by continuing our walk for a quarter of an hour longer, we came in sight of the low, flat part of the island, to which we descended by a winding road. This flat is much exposed on all sides, excepting on the south, where it is defended by the lofty cliffs, which are the termination of the hilly grounds of Skye, and also form the boundary between this part of the parish of Kilmuir and the other parts of Skye. It appears very certain that this flat, at some distant period, was of an equal height with the adjacent mountains; but probably the violent agitations which took place at the Deluge, or some very remote period, may have either swept away the land which is here wanting, or violent earthquakes may have sunk it nearly to its present level. It could not have been carried away by the slow action of the sea, as there are no marks of the sea having lately covered it; nor can

we

we suppose that the combined meteoric influences could, in any length of time, have produced this appearance.

The most prevalent rock of this flat is basalt; but upon the shore I observed some variety of strata, of which I shall now give a short account. Upon the shore, near to the house of Mr Martin, the minister of the parish, there are cliffs of moderate height, where the lowermost stratum is basalt: above this is a stratum of blue shistose clay; then a stratum of bluish-coloured limestone, a foot and a half wide; and above this is another stratum of blue shistose clay. At some little distance from this, I observed strata of compact blue limestone, which are from 8 to 14 inches thick, alternating with layers of black-coloured shistose clay, and both are traversed by basalt veins. To the westward of this the strata are arranged in the following manner—

1. Lowermost stratum, composed of basalt.
2. Blue-coloured shistose clay.
3. Argillaceous sandstone.
4. Blue-coloured shistose clay.
5. This rock differs from the shistose clay, in wanting the shistose fracture, and being so hard as not to be touched by the knife.

6. Blue

6. Blue shistose clay. This rock is sometimes very compact, and approaches to the nature of Lydian stone.
7. Sandstone.
8. Shistose clay.
9. Basalt, which forms the upper stratum.

These strata are in general very thin, being from 4 to 12 or 14 inches thick; but the uppermost stratum, the basalt, is of vastly greater thickness.

We now walked along the coast towards Duntulme Castle, but observed no variety of strata besides what we have now mentioned: the gradual breaking-down of the rocks formed, however, a striking object. In some places, the ground on the top of the high cliffs was to be observed rent for several hundred feet, only waiting the effects of frost to separate masses of vast magnitude. Many such masses were seen near to the shore; and it was pleasing to observe how nature, by the breaking-down of these masses, and covering them with vegetation, has formed many small, green hills, which gradually become useful to man, and hide the rude and broken appearance of the country. Some hundred yards from Duntulme Castle, I observed a stratum of shelly limestone, about 6 feet thick, resting upon a thin layer of shistose clay, which again lies upon a sandstone.

It is remarkable that this limestone contains pieces of wood slightly carbonated, being in a far less altered state than the wood found in the basalt tuff of the rock at Canna. At a little distance from these, but nearer to Duntulme, I observed three singular patches of Lydian stone, which, from their black colour and glimmering lustre, are, at a distance, much like black pitchstone. These masses, which are the remains of a stratum that has been broke away by the sea, lie upon blue-coloured limestone, and appear to be covered with sandstone: but I am not quite certain as to this latter fact. These strata are traversed by two basaltic veins, which cross each other, in such a manner, that the Lydian stone, at first sight, seems inclosed in a basaltic hollow. At Duntulme, formerly the seat of the Macdonalds, the cliffs, upon which the ruins of the castle are perched, are of considerable height, and seem to consist principally of basalt. Mr Pennant remarks that in these cliffs there are numerous small compressed ammonitæ *. It is to be regretted that he has not mentioned, whether it was really the basalt in which they were immersed, or rather a stratum of limestone: the latter, to me, seems more probable,

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* Pennant's Tour in Scotland, and Voyage to the Hebrides, p. 304.

As we proceed towards the north point of the island, the coast becomes high and rocky: the cliffs are seen to have been torn asunder, and great masses project in terrific grandeur from their tops. Upon the most northern point, the rocks are precipitous, and of great height. In one part they are particularly grand: we were upon the summit, and the burning of the kelp below enveloped their base in murky darkness, while the waves, broken into irregular points, were indistinctly seen lashed into foam. From this, looking northwards, the point of the Lewis retires beautifully into a low track of land; and, towards the east, the mainland melts into the horizon, and at last is distinguished only by the fleecy clouds that are attracted by it. Such an appearance must be grateful to the sailor, when his eye has been long fatigued with the weary sameness of the ocean, before land is perceptible, it is known by the appearance of the clouds on the horizon.

We now walked through a considerable extent of country to Loch Staffin, which is situated upon the east coast of the island; but in this track I observed no other rocks besides basalt and wacken, which are in some places traversed by basaltic veins. At Loch Staffin, the country on the shore is low; but on one side there is a small hill, which, at a distance, has a very reddened and burnt appearance, so that it may with all pro-

priety pass for a *Scottish* volcano: but a nearer examination discloses its structure, which is an alternation of basalt and common wacken, with red-coloured wacken. The quantity of this red wacken is very great; indeed more so than I have observed in any other part of the Hebrides. At some distance from the shore we observed a range of hills, which rise from the low part of Kilmuir parish, and, we were told, extend to Portree. These hills, which appear entirely basaltic, are here much broken; and the separated masses are to be seen gradually mouldering down, and at length covered with vegetation. If we examine this breaking-down of the land with more attention, we shall find a beautiful progression. First, we observe immense masses, which, by their vicinity to the cliffs, and their peaked form, indicate that they have been lately rent from the mountain. At some distance, other masses are to be seen, where the sharp, peaked form is worn away, and now they have a flat and rounded form, and are partly surrounded by debris. Still nearer the sea, the masses disappear under the covering of debris; and now vegetation makes its appearance, which increases more as we come to the flatter parts of the country. At a little distance from Loch-Staffin we observed a beautiful fresh-water lake, called Shiant, or The Sacred Lake. Its banks are covered with natural wood, and it is filled by numerous springs; so that its water is cool, clear, and refreshing. It has

not

not escaped the particular regard of the inhabitants, who formerly frequented it in great numbers, as it was reckoned sacred, and capable of healing all diseases. From this loch we walked for a short way through corn fields, and then along a dreary moor, which was bounded, upon one side, by the range of hills which extend to Portree, and, upon the other, by the ocean, and the distant mountains of the mainland of Scotland. The silence of the scene was broken only by sounds which rendered it more dismal—the mournful whistle of the plover, or the wild notes of the curlew; while the fullen roar of the ocean came at intervals upon the ear, as it heaved its mighty surges on the shore. The day, which was for some time extremely delightful, began to lour, the wind arose, and we saw the clouds gathering upon the neighbouring mountains. To avoid the coming storm, we hastened to pass the muir, that we might reach the path which leads across the mountains. After a journey of several hours, we came to the bottom of the mountains: they were enveloped in clouds, and the rain was falling in torrents. Fatigued by a long march, and with our clothes wet and clinging about us, we had still the steep ascent of the mountains, which divide the northern part of the island, before us. We began to ascend, and persevered in climbing against the blast: the long heather, and the wetness of the ground, increased our toil; but at last we gained a considerable plain.

Sometimes we were involved in impenetrable mists; but we could look back, at intervals, upon the plain country we had left, still partially illumined by the sun, and smiling faintly through the veil that furrounded us. As we continued to ascend, the thickness of the mist was terrible. Our guide began to talk seriously of his doubts and fears; assuring us that frequently people, going in search of cattle among the mountains, were overtaken by these mists, and forced to sit quietly down, and wait for the morning. The situation forcibly impressed us with the truth of what he related; and we entered with a lively sympathy into the anxiety and despair, and vain struggles, of those who are left thus to wander alone. While we went musing on our situation, and indulging in imaginary distresses, our guide pointed to the cairn of a poor shepherd who had perished in the snow. It was the very scene that Thomson must have painted,

Where many hills ascend, of unknown, joyless brow,

And many scenes of horrid prospect rise.

We could fancy we saw the unhappy man, with desperate effort, hurrying through the waste,

From hill to dale still more and more astray,

Impatient—through the drifted heaps,

Stung with the thoughts of home: the thoughts of home.

Burst:

Burst on his nerves, and call their vigour forth

In many a vain attempt——till down he sinks

Beneath the shelter of the shapeless waste,

Thinking o'er all the bitterness of death.

Having contemplated the unhappy fate of this poor shepherd, we paid the tribute of a stone to his cairn, and passed on. We found a narrow sheep-track, by which we scrambled upwards, but the torrents of water which were dashing upon all sides, rendered the ascent very fatiguing, and sometimes dangerous. At length we reached the summit, from which we were glad to descend quickly towards the low country. About half way down the mountain, the clouds appeared clearer, the rain was less violent, and suddenly, as by enchantment, we burst from clouds, and saw the country smiling below us. When we descended from the mountain the sun was setting; the evening was placid and serene; all the landscape was "mellowed by the gradual dusky veil." We now walked onwards when our fatigues were forgotten in the pleasures of the hospitable family of Kingburgh.

This tract of country over which we had passed, appeared to be entirely composed of basalt and wacken. We now passed a few days at Kingburgh, and then left with much regret
a family,

a family, to whose extreme kindness and hospitality, we had been so much indebted, during our stay in this part of the island.

Mr Campbell, who was going to the south part of Skye, accompanied us to Portree. The hills in this direction are not of great height; but as we approach Portree, they become higher, and upon the summit of one of them there is said to be the *crater of a volcano*, where probably there may be still sufficient heat to revive the drooping spirits of some forlorn fire philosopher as he wanders through this cold, bleak country. The strata are either basalt or wacken; and the latter often contains a very great quantity of zeolite, indeed sometimes it forms nearly one half of the stone.

Portree is a harbour of considerable extent, and capable of admitting vessels of some burden; it is besides very safe, as it is well defended by the island of Raza, from which it is only about three miles distant. Here there is a considerable thorough fare; and as it is the principal market place in the island, of course there is an inn. There are in the Highlands, as in other countries, places where strangers find bad accommodation; but certainly the inn of Portree has seldom been equalled for dirtiness: a traveller from among the Hottentots might

might well recognise the *Kraal*, although so far removed from its customary situation. Upon the north side of the harbour, there are rocky cliffs, which increase in height from the inn to the entrance of the harbour, where they are very bold and striking. Near to the inn, the cliffs are formed of a reddish coloured argillaceous rock, which is much of the nature of sandstone, and contains pieces of basalt, and is also traversed by basaltic veins; but the higher cliffs present a sandstone which contains numerous petrefactions, and alternates with basalt. This alternation of sandstone probably continues all along the shore to the muir near Loch Stafling. Upon the south side of the harbour I observed a stratum of coal, from one to two feet wide, resting on basalt, and covered by a similar mass from 16 to 20 feet high. In the coal I saw several pieces of carbonated wood, which could not possibly be distinguished from pieces of common carbonised fir. This does not seem to be a common appearance, for Emmerling only relates two instances, the one observed by Dr Reufs, the other by Mr Flurl. As we approach the mouth of the harbour on this opposite side, the cliffs rise to a great height, and are composed of sandstone and basalt, which alternate; and the basalt, from its being the least destructible, seemed always to form the higher and more exposed parts. The sandstone at a distance has the appearance of a breccia composed of great rounded masses,

masses, but upon a nearer examination, I was surprised to find it in large oval or globular shaped masses, as is the case with many kinds of basalt, and some kinds of granite.

This appears also to be a rare phenomenon in other countries, as I find it only mentioned by Dr Reufs, who observed globular sandstone in the Bunzlauer circle in Bohemia*. Having procured a boat, we sailed along the coast to Kaimiskianeveg, where we were told that coal had been discovered. The coast all the way is apparently sandstone and basalt, being a continuation of the strata from the south side of Portree harbour. Having landed, I observed in a cliff, about 40 feet above the level of the sea, a stratum of coal, covered by basalt, but unluckily the whole cliff was so concealed with vegetation, that neither the extent nor direction of the coal could be discovered. Nearly at the bottom of this cliff I observed a great stratum of the common argillaceous sandstone, and part of it was globular, like that at the harbour of Portree. From this towards Sconser the cliffs are in general lower, but the sandstone is not now to be seen, basaltic cliffs, as far as I examined, appearing to bound the coast. I cannot omit mentioning another appearance of coal, which I examined upon the coast opposite

* Reufs mineralogische geographie von Boehmen. B. 2. 45.

opposite to Clachan in the island of Rafay. It is a seam of coal about two inches wide, and visible for about 30 feet, but it is waved in its course. The upper and lower sides are bounded by shistose clay. Above this clay there is a thin stratum of Lydian stone, and this is again covered by great cliffs of basalt. From this the basaltic rock continues nearly to Sconser, where the high mountains connected with the Cullin groupe, now make their appearance immediately on the shore. Above the post-house of Sconser, rises the high hill of Glamofcard, which we ascended in order to have a view of the Cullin mountains from this side of the island. The shore and lower part of the mountain is formed of red coloured argillaceous sandstone: to this succeeds a more compact and nearly siliceous sandstone, but it continues only for a short way, for as the mountain becomes steeper, we find it formed of great strata of porphyry and wacken, and both are traversed by basalt veins. These strata continue to the summit of the hill, which has a burnt or reddish brown colour, owing to the cover of decomposed porphyry. The neighbouring mountains, as seen from this elevation, seem to rise to a great height, and are separated from each other by extensive vallies, which have a striking appearance, owing to the red colour of the bounding mountains. In descending, we were obliged to take the lea-side of the mountain on account of the violent wind; this was a fortu-

nate accident, for while walking in this direction, I observed numerous fragments of yellowish, and green coloured pitchstone. This was to me an interesting fact, as I had never before observed pitchstone among porphyritic rocks: I therefore examined all around very carefully, in order to discover if possible whether it was disposed in strata or veins. I was not so fortunate, however, as to determine this point, on account of the great covering of debris; yet I am inclined to suspect that it is disposed either in very thin strata, or in veins, as the quantity of debris seemed too small, for supposing that great strata existed near this spot. As the determination of the geognostic relations of this fossil, is an object of much consequence, I would earnestly recommend a careful examination of this mountain to future travellers. To do this at sufficient leisure, it will be convenient to spend some days at Sconser, and from this to examine Glamascard, and the neighbouring mountains, where most certainly they will be able to discover the relative position of the pitchstone to the other rocks. To assist in this investigation, I may mention that pitchstone has been found among similar rocks in different parts of Europe; thus in Misnia, great strata of pitchstone, are observed alternating with porphyry *. Esmark, a well informed pupil of Mr Werner, describes

* Emmerling Mineralogie.

describes it as alternating with porphyry in Hungary†; and Voight found it at the foot of Schneekops in the forest of Thuringia, among rocks of porphyry, but he does not mention whether it was in strata or veins.

From Sconser to Broadford we sailed along the shore thro' the sound formed by the islands of Rafay and Scalpa, which was bounded on one side by lofty magnificent mountains. These hills, as far as the weather would permit me to examine, appeared to be composed of porphyry; and upon the shore, in place of the basalt and sandstone, was formed a compound of felspar and quartz, or what may be called granitel, which seems to rest on limestone, and is traversed by basalt veins. At Broadford, the shore is very low, and continues so to the Kyles of Skye; the country is pretty flat, affording an agreeable scene after so long wandering among mountainous ruggedness. From Broadford to Cory, the country is low, but is bounded upon both sides by hills, thus forming an irregular valley, which extends to Loch Slepin, upon the opposite side of the island. The low part of the valley, appeared to be principally composed of the above-mentioned granitel; which, as is the case with the other, sometimes contains a little chlorite; and in other instances, seems passing to porphyry. Upon one side, there is a

M 2

range

† Neues Bergmanisches journal.

range of blue limestone hills, which rise from the shore at Broadford, and continue increasing in height to Suwardel, which is the highest part; whence they run in an irregular manner towards Loch Slepín. This limestone, which is of a blue colour, is in many places traversed by basalt veins, which are often of great size, and run in different directions. Upon the opposite side of the valley, Ben-na-callich and the neighbouring mountains, form a tremendously sublime boundary. As our time would not allow us to examine all these mountains, we agreed to ascend Ben-na-callich; we did this the more readily, as we knew from Mr Pennant, that from its summit, there was a vast display of mountainous scenery. After leaving the house of Cory, on our way up the mountain, the first object which attracted our attention, was a fine white calcareous marle, which forms a bed of considerable thickness. Upon examining particularly, I observed mixed with it, masses of white and grey marble; and these were seen in all the stages of decomposition, until they formed a substance not distinguishable from the marle. This fact renders it probable, that the whole bed is formed by the debris which has been washed from the neighbouring marble strata. As we continued our ascent, the mountains became more steep, and we observed the crop of blue and white coloured marble, which formed a striking contrast with the brown burnt-like aspect.

aspect of the heath. As I could not at this place discover how these marble strata were disposed, I descended into one of the numerous ravines which furrow the side of the mountain, where we judged it probable that their position might be determined. The bottom of the ravine was formed of white marble; but upon the sides, I observed rocks different from any which had been seen in the other parts of the island; but unluckily, they were so discomposed and covered with debris, that I could neither determine their situation with regard to the marble, nor their particular nature. I therefore continued my examination along the ravine, until I discovered the marble covered with a stratum of hornblende rock, which had much the appearance of basalt: and higher up the mountain, in another ravine, it appeared nearly in contact with a granite similar to that which forms the bottom of the valley; but I could not determine whether there was any interposed hornblende rock. Besides this hornblende rock, I also observed masses of greenstone, and a porphyritic rock, which has a basis of quartz penetrated with hornblende, and immersed in it a few crystals of felspar. This part of the mountain seems also to contain either strata or veins of dark nearly leek-green-coloured pitchstone: as I picked up several fragments that were scattered among the heath—As we continued ascending, the marble disappeared, and also the heather; the mountain side being now covered with

with loose stones, which rendered our further progress difficult and tedious. This debris is formed by the breaking down of the granitel which forms the hill to its summit; it is different in appearance from that of true granite, basalt, or granulated quartz; and although it cannot be characterised in writing, yet, an attentive examiner, is much struck with the peculiarity of its appearance. Amongst the debris, I observed masses of greenstone; but had not an opportunity of determining, whether it formed strata or veins. After scrambling over this debris, which covers so considerable a part of the mountain, we came to a green spot; from whence, the ascent is easier. We now hastened with eager step towards the summit, and soon reached the cairn, which is upon the most elevated part of the mountain. Here, our most sanguine expectations were more than realized, every faculty for a while seemed arrested, until we could burst into an exclamation on the vastness of the scene, and on the mighty and eternal power of him who framed so great a work. Before us, were many great vallies bounded by lofty mountains, whose steep sides were red, owing to the powerful influence of the elements, and furrowed by the many torrents which collect during the dreadful storms that often reign in these wilds. At a greater distance, the dark, lurid and terrible summits of the Cullin mountains retiring in majesty among the clouds; thus dimly seen, adding
much



Engraved by R. Scott & Son

VIEW from BEINN NA GALLIICH in SKYE.

much to the sublimity of the scene. To the north, we observed below us the low part of the island, with the isles of Rona, Rafay, Scalpa, and Pladda: towards the east and south, the rugged mountains of the mainland appeared stretching in all the grandeur of Alpine wildness to the point of Ardnamurchan; and nearer, the isles of Eigg and Rume added to the variety of this interesting prospect.—We stood long enraptured with the wonderful scene; but the darkening of the sky admonished us to shorten our stay, and hasten again to the valley. The clouds were now seen driving through the glens, and covering the mountains with a dark veil; soon all was lost in grand confusion; what a few minutes before was clear and distinct, was now a troubled scene of tremendous mountainous peaks, shooting above the dark clouds, and reddened valleys dimly seen through the driving mist and rain. We took the lea side of the mountain, and soon reached the house of Cory*.

As the weather continued stormy, we could not accomplish our intention of examining the mineralogy of the country about Loch Slepín, a circumstance which I regretted very much,

* Upon the summit of Ben-na-callich, I picked up several pieces of porphyry resembling that which forms the hill above Glamofcard.

as in all probability, it would have proved very interesting. We therefore left the kind and hospitable family of Coryhattican, to take a view of Sleat, which is the most southern parish in the island. Having reached Broadford, we walked through a dreary muir, to a small bay called Loch-in-daal, which is nearly opposite to the wild and romantic arm of the sea, called Loch-Huron. In this tract, we walked for several miles over a blue-coloured limestone, which by the action of the weather splits into thin rhomboidal-shaped masses, like the sandstone we observed near the Cock of Arran. To this succeeds a red-coloured argillaceous sandstone, which extends nearly to Loch-in-daal, when it is succeeded by an argillaceous breccia. This rock, however, continues only for a short way, when distinct primitive rocks, as gneiss, talcaceous schistus, and hornblende slate, are to be observed alternating with each other. The face of the country is now much altered in its appearance, the hills are low, and in place of brown heather, are covered with grass, and beautiful little tufts of natural wood, with interspersed cascades, increase much the beauty of the scenery. As we proceed onwards, the country increased much in beauty; and at Armidale, the seat of Lord Macdonald, where we terminated our journey through this island, there is a sweetly retired house and grounds, but in extremely bad order. As far as I could judge from a short excursion which I made

made, south from this place, the strata appear to be primitive to the extremity of the island; and these are principally talcaceous schistus, hornblende slate, and sometimes chlorite slate, and all traversed by basalt veins. The hornblende has sometimes interspersed crystals of actynolite.

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RASAR,



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RASAR, RONA AND SCALPA.
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 times interbedded crystals of actinolite.

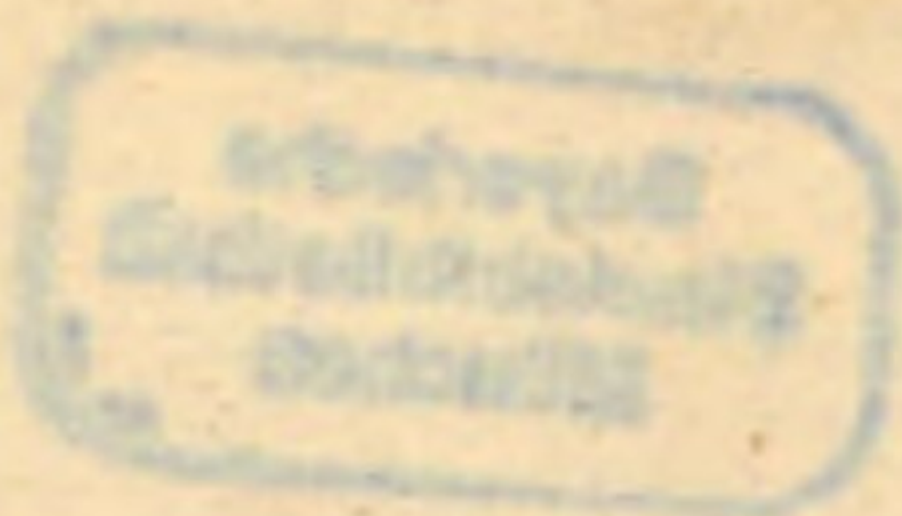
C H A P. XXII.

Outline of the MINERALOGY of RASAR, RONA, and SCALPA.

R A S A Y.

THIS island, which is the property of James Macleod, Esq. is about 15 miles long, and three miles broad: it is separated from the island of Skye by a sound about three miles over: it is low towards both extremities, but rises to a considerable height in the middle, forming the hill of Dun-can. The shores are in general rocky, and in some places the cliffs rise to a considerable height; but there are no caves of any considerable magnitude, nor is there a harbour in the whole island.

MIN-



MINERALOGY. The shore below Clachan, the pleasant seat of the hospitable Mr Macleod, is formed of white-coloured argillaceous sandstone, disposed in horizontal strata; but as we walk towards Swenish, we meet with argillaceous porphyry. At Swenish point the porphyry appears to lie on sandstone, and has, in many places, an iron-brown colour, owing to the decomposition of the iron pyrites which it contains. As we proceed towards the south part of the island, the porphyry still continues; but nearly opposite to Sconser, in the island of Skye, I observed, on the shore, blue-coloured limestone cropping through the debris, and it even continues to some height in the neighbouring grounds. At Rue-clachan, the most southern part of the island, the porphyry disappears, a sandstone breccia taking its place. In this breccia, besides the fragments of quartz, I observed small stratulae of red sandstone, and masses of a very beautiful porphyry, with a blue-coloured basis. From this, along a considerable extent of the east coast of the island, the cliffs are low; but, nearly opposite the island of Scalpa, they rise to a considerable height, and continue so to Brokel Castle. The prevailing strata in these cliffs are sandstone and breccia, which alternate. The sandstone has frequently a calcareous basis, and contains numerous impressions of shells, as pectines, &c.; and some specimens of the pectines which we observed were from 6 to 8 inches long.

long, and 4 or 5 broad. The sandstone, also, not unoften contains pieces of bituminated wood. Having reached the cliffs which are nearly below the hill of Dun-can, we ascended by a narrow path, and soon arrived at the top. I observed no interesting variety of rock: the strata, near the summit, being sandstone, which was in some places very hard; and upon the summit there were rocks of basalt, which had a considerable effect upon the compass. The view from this spot is very extensive; but what interested us most, was, the appearance of the north end of the island, and the isle of Rona, which, from their rugged, grey, sterile aspect, and their rising into low, irregular hills like Coll and Tirie, seemed to announce a similarity of composition. We now descended from this towards Brokel Castle, and in our course met with much red-coloured argillaceous sandstone, and in several places great masses of breccia. This castle is built upon a great rock of breccia, and is the most picturesque and striking ruin that we had observed in any of the Hebrides. A few yards from the castle, and immediately on the sea-shore, the secondary strata are terminated, when gneiss and hornblende-rock begin. At a little distance from where the sandstone disappears, I was so lucky as to observe a stratum of breccia, composed of fragments of gneiss, hornblende-rock, and quartz, lying on the gneiss: thus showing the junction of the primary with the secondary strata. The strata of
gneiss

gneifs continue to the northern extremity of the island, sometimes alternating with hornblende slate, and traversed by basalt veins: thus confirming the conjecture we had made on the top of Dun-can, that the north part of the island is of a similar composition with the islands of Coll and Tirie. The end of the island is separated from the small island of Rona by a narrow strait, in which lies the isle of Mattea, which is composed of similar rocks with this part of Rasay. As we return along the west side, the same kinds of rock still continue; but, near to the island of Fladda, I observed a small portion of secondary rock skirting the primary. As the appearances presented by the junction of the different strata, particularly that of the primary with the secondary, are highly deserving of attention, I landed upon the shore of Rasay, in the sound of Fladda, to examine the secondary strata I have just mentioned. These strata do not extend for more than 30 or 40 feet in all directions. The uppermost stratum is an argillite, or sheifer-thon; and, below, is a species of breccia, containing fragments of hornblende slate, gneifs, quartz, and hornstone; and from under this stratum rises the gneifs, which forms this part of the island. These secondary strata appear formerly to have been connected with those in the island of Fladda, as it is entirely composed of secondary strata of argillite and red sandstone; and, in a more extended view,

Fladda

Fladda appears to have formed a part of the strata which formerly joined with the sandstone cliffs upon the shore of Skye. After leaving this junction, the coast continues formed of the usual gneifs, &c. until we come to Loch-Arnish, where I observed great strata of breccia covering the gneifs. Nothing curious again occurred, until we landed upon that part of the island, which is, I think, about due W. from the castle: here the gneifs is covered with breccia, and the breccia is covered with red-coloured argillaceous sandstone similar to that observed near Brokel Castle. From these observations, it appears that the primitive rock occupies that part of the island which is included in the space marked A, in the map.

The red sandstone, which I have now mentioned, is elevated at an angle of 45° , and dips to the W. and continues for some miles, forming low shelving shores, or high cliffs; and as it rises into the interior of the island, the extensive, bare, exposed surface of the red sandstone has a striking appearance. As we proceed along the shore, we find it succeeded by white-coloured sandstone; but this continues but for a short way: as, nearly opposite to Portree harbour, felspar-porphry makes its appearance, forming low cliffs upon the shore, or rising upwards to within 30 or 40 feet of the summit of Dun-can, thus forming the west side, as the sandstone does the east. It continues
also

also to form the rocks upon the shore, and the hills, until we come within half a mile of Clachan, where basalt rocks begin, and continue nearly to Mr Macleod's house. This basalt does not rise to any considerable height, and the porphyry is to be seen rising from under it; but I was not so fortunate as to observe their junction.

The whole of the porphyry is evidently of secondary formation, as it does not extend beyond the line A, which I have before mentioned as the boundary between the primary and secondary strata. It seems to form the basis of the south part of the island; and it is probably covered by the sandstone and basalt, or they may alternate with each other. A disposition of strata, pretty nearly similar, has been observed in other parts: thus, Kohler, in the Miner's Kalendar for 1790, observes, that sandstone and porphyry are sometimes connected together, and it is then of secondary formation; and, in the island of Arran, we have already observed porphyry resting upon sandstone.

RONA.

R O N A.

THIS island, which is also the property of James Macleod, Esq. of Rafay, is about four miles long, and separated from Rafay, as I have before mentioned, by a narrow channel. It is bare and rugged, and rises into irregular hills, like those in the north part of Rafay: the shores are rocky and dangerous, and there is no harbour.

MINERALOGY. The strata, in general, do not differ much from those that form the north end of Rafay; being an alternation of gneiss, micaceous schistus, and hornblende-rock. Many granite veins are to be observed traversing these strata in different directions, and they are from one foot to ten feet wide. They are to be distinguished at a considerable distance; not only by their running in a cross direction to the strata, but also, by reason of the great size of the crystals of felspar, which are sometimes 12 inches long. The only other appearance of consequence, which I had an opportunity of examining, was at

Tuhumas

Tuhumas, or Blue-Bay: here there is a mass of rock, which is composed of chalcedony, hornstone, and quartz, from 12 to 15 feet wide, and extending for a long way, and bounded on both sides by gneiss. I regret that I had not sufficient leisure to determine with certainty whether it forms a stratum or a vein: the determination of this point, however, is well deserving the attention of mineralogists who may visit this island.

S C A L P A.

THIS small island, which is the property of Lord Macdonald, is about $2\frac{1}{2}$ miles long, and 1 mile broad: it is hilly, and the shores are low.

MINERALOGY. At Mr Macdonald's house, the shore is low, and is formed of blackish-coloured argillaceous sandstone, which contains numerous impressions of shells and zoophytes. This sandstone, with an alternation of limestone, continues to the northern extremity of the island: here, however, a red-coloured sandstone, alternating with common sandstone-brec-

cia, makes its appearance, and continues around the whole east and south sides of the island, until we again come to Mr Macdonald's. The higher parts of the island are entirely composed of a granite similar to that of Ben-na-cailigh; but I could not determine its situation with regard to the sandstone: it is probable, that the sandstone covers it.

SKYE,

SKYE, RASAY AND RONA.

C H A P. XXIII.

Description of the FOSSILS mentioned in the preceding Chapters.

SIENITE—*Cullin Mountains, above Rue-dunan.*

The sienite of these mountains, like that of the island of Arran, is small-grained, and extremely compact, and also varies much in the proportion of its constituent parts. I shall not now give any more particular description, as it would be pretty nearly a repetition of what I mentioned when describing that of Arran; and have only to mention, that we frequently meet with beautiful nests of glassy actynolite dispersed through it.

WACKEN—*Uig Mill Water.*

This has the common character of wacken; but it has, interspersed, balls of calcareous spar, zeolite, and soap-rock, both in balls and irregular pieces.

The SOAP-ROCK, or STEATITES, has the following characters—

Colour. White, greenish white, dark green, and sometimes brown and blue.

Lustre. None.

Transparency. Allows light to pass freely through the edges, but is also sometimes nearly opaque.

Fracture. Fine splintery.

Hardness. Scrapes easily with the nail.

Trace—upon paper, is glimmering, and takes a polish with the nail; and feels greasy.

The white kind is marked by dendritical figures, and is the same with the chalk of Briançon, and, intermixed with it, are frequently beautiful white fibrous zeolites. It is used in Cornwall

wall for the making of porcelain; and were it found in considerable quantity in Skye, might also be of considerable value.

At a meeting of the Electoral Academy of the Useful Sciences at Erfurt, C. A. M. Baron Von Dalberg read a paper on steatites, in which he shewed, that, when cut into figures, and then burnt in a close vessel, it acquires a hardness that will resist the file. He also related a series of experiments he had made, on the method of giving a durable dye to hardened steatites; by which it appears, that it may be made to imitate the most esteemed and beautiful kinds of stone. In the specimens laid before the Society, the hardened steatites had taken a very remarkable degree of polish, and the heads that were cut on it were very beautiful.

LYDIAN STONE, *which covers the Coal, in Skye,
opposite to Clachan, in Rasay.*

Colour. Black.

Lustre. Faintly glimmering.

Transparency. None.

Hardness. Gives fire very plentifully with steel.

Fracture. Uneven, with a tendency to the conchoidal.

This

This stone is described by Pliny, who mentions that it is found in great plenty in Lydia, in the lesser Asia. It was much used by the ancients as a touchstone for trying the purity of gold or silver. It is now known, however, that any stone, which has a black colour, and a sufficient degree of hardness, will answer equally well.

SHISTOSE CLAY, *which covers the Lydian Stone.*

Colour. Black.

Lustre and Transparency. None.

Fracture. Even; in the gross, flaty.

Hardness. Yields with difficulty to the knife.

Streak. Dark-brown.

PORPHYRY—*Hill of Glamoscard, Skye.*

This porphyry has, in some instances, a base of hornstone; in others, has more the appearance of indurated clay. It has crystals of white and red felspar, and also quartz, dispersed thro' it. By decomposition, it becomes white, and sometimes brown.

PITCH-

PITCHSTONE—*Hill of Glamofcard, Skye.*

Colour. Dark refin-brown.

Lustre. Refiny, and nearly strong-glancing.

Transparency. Transmits light at the edges; but, in thin pieces, it is femi-transparent, and has a fine amber colour.

Fracture. Uneven, and conchoidal.

Hardness. Does not yield to the knife, and gives a few sparks with steel.

Interpersed there are a few crystals, which appear to be felspar.

Blackish-green. PITCHSTONE—*Hill of Glamofcard, Skye.*

Colour. Light blackish-green.

Lustre. Waxy.

Transparency. None.

Fracture. Uneven, with a number of rounded, distinct concretions: in the gross, it is frequently shistose.

Hardness. Gives fire very difficultly with steel.

Has, dispersed, a few crystals of white felspar.

In some specimens this Pitchstone has the following characters—

Colour. Pretty dark blackish-green.

Lustre. None, or extremely little.

Transparency. None.

Fracture. Even, with a tendency to conchoidal.

Hardness. Gives fire plentifully with steel.

It is alternated with layers of a whitish-coloured substance which resembles hornstone, and a few crystals of felspar are dispersed through it. This seems to be one of the links of a gradation to hornstone, or some similar rock.

WACKEN, *which alternates with the Porphyry,*

upon the Hill of Glamofcard, Skye.

Colour. Light greenish-grey.

Lustre and Transparency. None.

Hardness. Yields rather with difficulty to the knife.

Streak. Light grey.

Smell. Strong earthy.

It

It contains frequently yellowish-green coloured crystals, probably actynolite, and sometimes reddish crystals of felspar.

GRANITE.

SAXUM MORENSI, Lin. *GRANITES SIMPLEX*, Gmelin. *HALB GRANIT*, Germanor.

This rock, which forms the upper part of Ben-na-cailich, in Skye, is composed of white-coloured felspar, and quartz; and, intermixed, there are a few dark-green points, which appear to be chlorite. Iron pyrites is sometimes observed; and this, by decomposition, gives a reddish tinge to the mountains.

MARBLE—*Cory, Skye.*

1st SPECIES.

Colour. White, and veined with ash-grey.

Lustre. None.

Transparency. Transmits light at the edges.

Fracture. Even, fine splintery.

Hardness. Yields with some difficulty to the knife.

It is very heavy; and, by exposure to the air, it washes down into a powder, and forms calcareous marle.

2d SPECIES.

Colour. Ash-grey.

Lustre. Has a slight degree of lustre, from a number of very minute foliæ.

Transparency. Transmits very little light at the edges.

Fracture. Coarse splintery.

Hardness. Yields pretty easily to the knife.

It feels very heavy; and is variegated by beautiful citron-yellow coloured stripes, which traverse it in different directions. These yellow stripes seem to be owing to an intimate combination of chlorite, or hornblende, with the marble.

3d SPE-

3d SPECIES.

Colour. Snow-white.

Lustre. None; or extremely little, from very minute foliæ.

Transparency. Transmits light at the edges.

Fraçture. Even, or very minutely granularly foliated.

Hardness. Yields pretty easily to the knife.

Feels very heavy. Sometimes it has a brecciated appearance, from its containing masses of marble of a harder texture. By the action of the weather, it decomposes, and forms a marl.

4th SPECIES.

Colour. Pure white, mixed with bluish grey.

Lustre. Pretty considerable, from the number of foliæ.

Transparency. Allows light to pass at the edges.

Fraçture. Granularly foliated.

Hardness. Yields pretty easily to the knife.

This species differs from the fine marble of Carrara, only in the slight admixture of the bluish-grey colour.

FELSPAR PORPHYRY—*Rasay.*

This porphyry has a basis which is composed of minute crystals or grains of felspar and quartz, with generally a few specks of hornblende or chlorite; and in this basis there appear pretty large crystals of reddish or white-coloured felspar, and sometimes crystals of quartz. Often it is merely a compound of crystals of felspar and quartz, forming a stone like that of Ben-na-cailich in Skye. This porphyry differs from the sienite-porphyry of Werner, in containing a greater proportion of felspar, and comparatively little hornblende. Esmark* informs us, that the Schemnitz and Cremnitz mining-fields, in Hungary, are situated in sienite-porphyry; and also, that he observed it alternating and passing into clay-porphyry. This latter fact shows us that similar alternations and gradations may be discovered in Rasay; as I remarked clay-porphyry, in several parts of the island, intermixed with the felspar-porphyry.

Indigo-

* Neues Bergmannisches Journal, bande 1, 2.

Indigo-blue coloured HORNSTONE PORPHYRY—*Rasay.*

Colour. Pretty dark indigo-blue (hoch indig blau).

Lustre and Transparency. None.

Fracture. Even, with a tendency to the conchoidal.

Hardness. Strikes fire very plentifully with steel.

Smell. Faint earthy.

It has, dispersed through it, yellowish-coloured crystals of felspar, and also quartz of the same colour, which is sometimes in the form of six-sided pyramids. This beautiful species of porphyry seems to be intermediate between clay and hornstone-porphyry, but, by reason of its hardness, it is more of the nature of hornstone.

CHALCEDONY—*Rona.*

Colour. Grey, brown, or greenish.

Lustre. Glimmering, with a greasy lustre.

Transparency. Allows light to pass easily through it.

Fracture.

Fraçture. Compact; sometimes passing to the splintery.

Hardness. Gives fire with steel more plentifully than flint.

It is sometimes intermixed with the gneiss, in which it lies; and very thin stripes of a yellow and white-coloured substance alternate with it: so that, at first sight, such specimens are not unlike petrified wood.

CHALCEDONY, penetrated with Hornblende—*Rona.*

Colour. Siskin-green, of various shades; and sometimes dark leek, or mountain green.

Lustre. None, or hardly perceptible glimmering.

Transparency. It has more or less transparency, according to the intensity of the green colour. If the colour is very pale, the transparency does not differ from common chalcedony; but as the colour approaches to dark leek-green, it becomes less transparent, until it is quite opaque.

Fraçture. Compact, even, and sometimes splintery.

Hardness. Is much the same with chalcedony, excepting when much hornblende is combined, when it is somewhat softer, and has a greater specific gravity.

QUARTZ

QUARTZ—*Rona.*

Sometimes the quartz has a beautiful green colour, owing to diffused hornblende; and frequently the nearly-transparent quartz is variegated with beautiful spots and stripes of a fiskeen-green colour: thus forming a beautiful fossil. It is also to be observed of a red colour; and, being mixed with the common quartz, it is not unlike a granitel.

ON PEAT.

CHAP. XXIV.

Observations on PEAT.

AS this substance is mentioned in all the Systems of Mineralogy, and as it occurs in great quantity in the Islands which I have just described, I do not think it necessary to apologise for the publication of the following observations and experiments. I proposed, in a former work *, to continue my investigations with regard to this substance, and had begun a new series of experiments, when the Highland Society, by offering a prize of 50 guineas for the best account of Peat, induced me to wait the publication of these prize essays, which will,

no

* Outline of the Mineralogy of the Shetland Islands.

no doubt, contain many new observations and experiments. If, however, the experiments, communicated in these memoirs, be different from what I had begun, I will certainly continue the plan I had laid down.

This curious and useful substance has been long known as an article of fuel to the inhabitants of the North of Europe, and used as such, in those regions where no coal has been found, to defend the inhabitants from the rigors of a frozen climate. The learned Torfæus informs us, that its use was first made known to the inhabitants of the Orkney and Shetland islands, by one Einar, a Norwegian, who, from that circumstance, was named Torf Einar. It soon after this came into very general use, and is now the only fuel of many parts, not only of the islands and Highlands of Scotland, but of other nations in the North.

In describing the general appearance of a peat moor, we may conceive an almost entire flat of several miles extent, of a brown colour, here and there marked with tufts of heather, which have taken root, owing to the more complete decomposition of the surface peat; no tree or shrub is to be seen; not a spot of grass to relieve the eye, in wandering over this dreary scene. A nearer examination discovers a wet spongy sur-

face, passable only in the driest seasons, or when all nature is locked in frost. The surface is frequently covered with a slimy black-coloured substance, which is the peat earth, so mixed with water, as to render the moss only passable by leaping from one tuft of heather to another. Sometimes, however, the surface of peat mosses has a different aspect, owing to the greater abundance of heath and other vegetables, as the *schoeni*, *scirpi*, *eriophora*, &c. but this is principally the case with some kinds of what are called Muirlands, which contain but little peat, being nearly composed of the interwoven fibres of the roots of living vegetables.

Many different species of peat might be described, but such an investigation is not suited to my present purpose; I shall therefore content myself with mentioning the substance in a general way. Quick moss (as it is called) is a substance of a more or less brown colour, forms a kneadable compound, and when good, cuts freely and clean with the spade; but when it resists the spade, by a degree of elasticity, it is found to be less compact when dried, and is of an inferior quality. The best kinds burn with a clear bright flame, leaving light coloured ashes; but the more indifferent kinds, in burning, often emit a disagreeable smell, and leave a heavy red-coloured kind of ashes. In digging the peat we observe that, when first taken
from

from the pit, it almost immediately changes its colour, and in time becomes more or less of a deep brown or black colour; and the peat matter becomes much altered, being incapable of forming a kneadable paste with water. When dry and reduced to powder, as it is often by the action of the weather, it forms a blackish-coloured powdery matter, capable of supporting vegetation, when calcareous earth is added. Peat earth is very retentive of moisture, which circumstance affords us a satisfactory explanation of the floating islands, observed in many places of Holland, as Frise, Breme, Groningue, Oldenburg, &c. These are caused by the peat earth or turf, retaining so great a proportion of water as to float immense masses of it, which are driven about upon the surface of lakes, or are floated upon the land itself. This is so well known in Holland, that tracts of moss, of great extent, are secured by means of chains, &c.

Peat is found in various situations, often in vallies or plains, where it forms very extensive deep beds, from three to forty feet deep, as those in Aberdeenshire; it also occurs upon the sides of mountains, but even there it is generally in a horizontal situation. The tops of mountains, upwards of two thousand feet high, in the Highlands of Scotland, are covered with peat of an excellent kind. In Germany, it is also found at

very great heights; thus the Blogfberg, a high mountain in Lower Saxony, and the Brohen, the highest mountain in the Hartz, are covered to their summit with peat. It is also found in situations nearly upon a level with the sea; thus the great mofs of Cree in Galloway, lies close upon the sea, on a bed of clay, little higher than flood-mark at spring tides; Locker-mofs, hard by Dumfries, about ten miles in length, is only a few feet above high water mark; in the island of Lewis, one of the Hebrides, there is an extensive plain, about thirty miles long, covered with peat mofs, having its surface very little elevated above that of the sea. In other places, as in Holland, a kind of peat is obtained by dragging mud from the bottom of canals, and moulding it into the form of bricks; this species is also often taken up upon the flukes of anchors, on the coast of Holland, and is sometimes cast ashore in stormy weather, which has led some speculators to imagine that it is of marine origin. In the harbour of Oban in Argyleshire, one part of the bottom appears to be formed of quick mofs, which affords no sure anchorage. The depth of the sea is there about twenty fathoms*.

Sometimes peat is to be observed alternating in thin strata with sand or clay: of this, I have observed instances in the Orkney

* Anderson's Treatise upon Peat Mofs.

Orkney islands; and in the second volume of the Journal des Mines, I find similar appearances noticed in France.

It appears to be peculiar to cold climates, which is one of the innumerable instances of the wisdom of nature in providing the inhabitants of a cold country, with a material so necessary for their comfort, and even their existence. Dr Anderson, in his Treatise upon Peat, remarks, that it is not confined to cold climates, as he had specimens of real peat sent from the island of Sumatra. It is not improbable that a substance resembling peat in some of its properties, may be found in the warmest countries, when we reflect that decayed vegetable matters, in a certain stage of their decomposition, have an appearance so like peat, that they want only compression to form a similar substance. On this account, it is not surprising, that something of this kind should occur in the warmer regions; but great masses of matter like our peat, can hardly exist in the Tropical regions. This observation is rendered more probable from the following remarks: In Scotland, it is observed, that the peat, at the bottom of a mountain, is more decomposed than at its top, and the wood of mosses is more fresh upon the higher part of a mountain than at its lower. It is also remarked, that the peat of the South of England is more decomposed than that of the North of Scotland;

land; and the peat of France has more of the coaly appearance, than that of England. In France also, Mr Arthur Young remarks *, that the peat is never found in the low lands, but under cover of vast size; and it is only in the higher regions, where the climate is more temperate, that it is to be observed upon the surface. All these facts show us, in a satisfactory manner, that as we advance towards the warmer climates, the vegetable matter is more and more decomposed, until we arrive at the Tropical regions, where, in all animal and vegetable matters, putrefaction proceeds so rapidly, as to prevent the formation of any body of this substance.

It will not be foreign to my present purpose, to mention, in a cursory manner, the most remarkable undecomposed vegetable matters, which have been observed in our peat mosses, or bogs; particularly as writers have endeavoured to draw conclusions, with regard to the time and mode of formation of peat, from the appearances which these bodies present.

1. FIR or PINE. This tree more frequently occurs, than any other; it is found of various sizes, some having been dug about one hundred feet long, perfectly strait, with branches growing in

* Travels through France.

in a circular form ; as is the case with the pine tribe. It is remarkable, that in such situations the wood has often lost its latitudinal adhesion, which renders it soft ; but that the longitudinal fibres are strong and tough, so that they are split, and twisted, to form halters for cattle, as in Aberdeenshire.

2. OAK. In all the low mores, in Scotland, this tree is the principal one which is to be observed, and is generally found wanting the bark, which shews that the wood had been long dead before it had been enveloped in the moss. In draining Hartfell level, in Yorkshire, oak trees were found, not less than 100 feet long. They were black as ebony, in excellent preservation, and some of them sold, in the middle of the last century for 15*l.* a tree. One of them, which is particularly described, was about one hundred and twenty feet long, twelve in diameter, at one end, and six at the other ; and 20*l.* was offered for it. Beckman also informs us, that wood which has long lain under water becomes black, and looks as if charred ; it however loses none of its toughness or compactness ; and many trees, dug up in Holland from the turf earth, are employed there for ship-building.* Dr Anderson remarks, that he never saw a piece of oak taken from a peat moss,

* Beckman, 6 vol. New Transactions of the Royal Society of Gottingen.

moss, which could be used in workmanship, like the stakes which were lately taken from the Thames, and said to have been placed there by Julius Cæsar; from this he concludes that moss does not preserve wood so long as water. This, however, is contradicted from the facts observed at Hartfell level, and that mentioned by Beckman.

3. BIRCH. This tree also frequently occurs in our peat mosses, but its wood is not so resinous as that of the fir, nor has it the hardness of the oak; on these accounts it is seldom found in a state of good preservation; the bark is generally the most entire, which may depend upon the great quantity of resin which it contains, which enables it to resist the all powerful hand of time.

The alder, yew, willow, ash, and several other trees, have been dug out of our mosses; but any detailed account of these would lead me to a great deal of unnecessary description: I may here mention, however, that, besides trunks and branches of trees, we also sometimes discover their more delicate parts in a state of preservation: thus, the leaves have been observed well preserved. Seeds, which have a remarkable power in resisting the influence of the weather, have been found in peat mosses; thus we have instances of fir cones and hazel nuts; the

the kernel of this last was destroyed, and the shell, which is very indestructible, was fresh.

Besides trees and herbaceous plants, another tribe deserve to be particularly noticed, which are the musci. These plants are fond of moisture, and, with a sufficiency of room to spread upon, and a cold climate, grow very fast and luxuriantly. Of these the most remarkable is the sphagnum palustre of Linnæus, which is found in great abundance in all peat districts, particularly in those places where the soft white peat abounds; this peat is found several feet deep, and is nothing but a collection of the sphagnum, which we can observe more or less decomposed as we go downwards; at last its texture disappears, its colour changes, and it cannot be distinguished from the common brown peat.

I have in my possession specimens of a substance, which was found in the peat mosses of the Highlands; it answers to the Bergfet of the Germans, the Mineral Tallow of Mr Kirwan.

Description. Colour, white; has nearly the resemblance of tallow, feels greasy, and stains paper as tallow does; flames with much smoke, leaving a pretty light coaly matter. It is brittle like tallow, but its specific gravity is considerably less.

A substance fimilar to this was found some years ago by peafants on the coast of Finland, afterwards in one of the Swedifh lakes; and, more lately, Dr Babington informs us that it is found in great quantities in New Holland. Some have imagined that it is tallow which has been accidentally depofited along with the peat, and, by long expofure to the influence of the vegetable juices, may have been altered. This cannot be the cafe, as we are utterly unacquainted with any fuch changes; and befides, the circumstance of its being found in great quantity in New Holland, leads us to fuppofe that it is not accidental. The editor of the Bibliotheque Britannique fupposes that it is a substance fimilar to the fatty matter into which the muscular fibre is converted, when long expofed in particular fituations.

A great number of extraneous fubftances have alfo been found in peat moffes, fometimes at confiderable depths; from their appearance, declaring, in certain characters, the great antiquity of fuch moffes. Many curious instances of this kind might be mentioned; one in particular deferves to be noticed. In digging a mofs at Axholm, in Lincolnfhire, the body of a woman was found pretty fresh, her hair was unaltered, her nails were rounded, and her fkin was tanned, foft and pliable; fhe had antique fandals upon her feet, which renders it probable

ble that she was of the Roman æra. Another curious instance occurred in Shetland; in digging a peat moss, the body of a man was found well preserved, which, it was supposed, could not have been in the moss less than eighty years. In the Irish mosses the horns of the moose deer have been found; in our own, the head and horns of the urus occur. Dr Walker has in his possession a drawing of the head and horns of a deer, found in a peat moss, of a species now no longer found in Britain. Other substances occur in mosses; thus, fragments of very ancient dress, and many instruments of human industry have, at different times, been discovered.

ANALYSIS OF THE PEAT OF GLEN-CLOY,

ISLAND OF ARRAN.

Character.

It is of a blackish brown colour, pretty much intermixed with undecomposed vegetable matter, which renders it rather loose in its texture.

R 2

Solution

*Solution in Water.**

1. I took one thousand grains of powdered peat, boiled it repeatedly with distilled water, until no more could be dissolved, then dried, weighed, and found eight hundred grains remaining.

The

* Lord Dundonald remarks, † that “the sulphuric acid, when concentrated, acts in a similar manner to that of alkaline substances, in the resolution or destruction of animal and vegetable substances, disengaging from them certain gasses, and forming therewith certain saponaceous and saline compounds. These solutions or extracts are of a reddish-brown colour, similar to that produced by the action of alkaline salts on oxygenated peat. On the principles already stated, the vitriolic acid may be used beneficially to decompose, and bring into action the insoluble matter accumulated in soils, by the combination of the phosphoric and foreline acids, with calcareous matter.” The action of the sulphuric acid upon vegetable substances engaged my attention five years ago, and in a paper read to the Royal Medical Society of Edinburgh, I endeavoured to shew (what has been since done more satisfactorily by Vauquelin and Fourcroy) that acetous acid is formed; that a portion of carbonaceous matter, deprived of hydrogen, remains in solution, and that carbon is separated. It is certain that alkalies exert no such influence upon vegetable

† A Treatise of the connection of Agriculture with Chemistry, 4to, by the Earl of Dundonald.

The solution had a deep brown colour, with a slightly bitter taste; tinged litmus paper; and, by exposure to the air for some time, part was precipitated in an insoluble state.

2. By passing the oxygenated muriatic acid through this solution, a precipitation of a dark-brownish matter immediately takes place, similar to what we observe by passing this acid through other vegetable infusions.

3. Caustic

vegetable substances; in the present instance, they only dissolve a portion of brown dehydrogenated matter, without causing any alteration in the proportion of the constituent parts. Their action upon animal substances, however, is more nearly allied: Vauquelin found, that ammonia was formed by the action of this acid; and I have reason for suspecting that a similar change is produced by the agency of potash or soda upon the muscular fibre. A series of experiments, which my father was lately engaged in, at the desire of the honourable Board of Trustees, led me to make this observation. We found that the muscular fibre of fish, formed a brown-coloured solution, by treating it with the caustic potash or soda: during the solution, a small quantity of ammonia was formed, but in a far greater proportion, when tallow is added and the boiling continued. During this extrication of ammonia, a blackish-coloured matter falls to the bottom, which is not acted upon by alkalies; in short, it appears to be the carbonaceous matter of the muscular fibre. This change appears to be a nearly complete decomposition of the muscular fibre, its hydrogen and azote forming the ammonia, whilst the carbonaceous matter is left behind, forming the insoluble matter. Vide Nicholson's Journal.

3. Caustic ammonia, or carbonat of potash, did not cause any precipitation in the space of twelve hours.

4. Prussian alkali did not afford any traces of the combinations of iron, copper, or zinc.

5. Lime water formed a copious brown-coloured precipitate.

6. Muriat of barytes, nitrat of silver, sulphat of iron, sulphat of copper, caused considerable precipitations; but nitrat of ammonia, muriat of soda, muriat of ammonia, did not produce any change.

The solution, being evaporated, left a blackish-brown coloured residuum, which had no peculiar smell. It presents the following characters:—

a. Not soluble in spirit of wine, except by a boiling heat.

b. Difficultly soluble in water, without the assistance of heat.

c. Soluble

c. Soluble in caustic soda, at the common temperature, or when heated.

d. Soluble in caustic ammonia, in the same manner.

7. A quantity of the residue being put into a retort, connected with a pneumatic apparatus, a gradually-increasing heat was applied, when the following appearances were observed. At first, water passed over, quite colourless; after some time, it was tinged brown; and towards the end of the operation, when no more brown liquor came over, carbonic acid, and carbonated hydrogen, passed in considerable quantity. No oil or saline matter could be detected, and not the least traces of ammonia could be perceived. The carbonaceous residue was of a blackish-brown colour; insoluble either in hot or cold water, but easily soluble in a weak solution of caustic soda.

The ease with which this carbonaceous matter is dissolved in weak solutions of alkali shows, that it contains a considerable portion of hydrogen; (at least this is the explanation given by modern chemistry :) for I find it impossible to dissolve any perceptible quantity of charcoal with such solutions.

8. The residue, by burning, affords a grey-coloured ash; which I examined, in order to ascertain the nature of the saline

line matters. It did not afford sulphat of potash or soda, phosphat of lime, or phosphat of iron; only *sulphat of magnesia*, and *oxyd of iron*.

To the eight hundred grains, which I found insoluble in water, I added a solution of caustic soda, which acquired a brown tinge at the common temperature; but, when heated, a very deep-brown coloured solution was formed. After repeated digestion with the alkali, I was able to dissolve four hundred grains: the remainder was undecomposed vegetable matter, which was quite insoluble in the alkali I used.

I next added muriatic acid to this alkaline solution; the dissolved matter was precipitated of a brown colour, and did not appear to be altered by its combination with the alkali: for it was still soluble in caustic soda and ammonia, insoluble in water by boiling, but soluble in spirit of wine. When burnt, a brown-coloured ash is left, which afforded sulphat of lime and oxyd of iron; but in no instance did I find phosphat of iron, or phosphat of lime.

Properties

Properties of the Acid contained in Peat.

In relating the characters of the aqueous solution, I observed that it tinged litmus paper red. This shows the presence of an acid, which I found to possess the following characters:—

1. It is not crystallizable, but may be obtained by evaporation, in the form of thin crusts.

2. Taste, slightly acid.

3. Forms compounds with lime, barytes, and soda; which I have not particularly examined. The compound of lime and this acid is difficultly soluble in water; which distinguishes it, on the one hand, from the Gallic acid, as it forms a very soluble compound with lime; on the other, from the oxalic, which forms an insoluble salt with lime*.

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* Lord Dundonald affirms, that peat contains the oxalic and phosphoric acids, which, according to his explanation, are of great use in several of the operations of nature: thus, when lime is added to peat, it is imagined that an oxalat of lime is formed; which, by the addition of sulphuric acid, is decomposed, and a gypsum formed;

4. Decomposes the acetite and nitrat of lead.

5. With fulphat of copper, a copious brown-coloured precipitate is formed, having a beautiful green supernatant liquor.

6. With fulphat of iron, it forms a brown precipitate, and a nearly colourless supernatant liquor.

7. Nitrat of copper changes the solution to a beautiful green, without causing any precipitation. In this it also differs from the oxalic acid, which causes a copious precipitation.

8. Muriat and nitrat of barytes are decomposed by it.

9. With a solution of fulphat of indigo, it forms a beautiful green colour: in this it also differs from the oxalic acid, which does not produce any change of colour.

This
formed; while the oxalic acid enters into new combinations, useful in promoting the growth of plants. We have already shown, however, that this acid of peat is very different from the oxalic; but, allowing it to be the same, it is contrary to well known chemical affinity, to suppose, that the sulphuric acid can decompose the oxalat of lime. In the experiments I have made, none of the combinations of phosphoric acid appeared.

This acid appears to be the same with the fuberique acid, lately discovered by Buillion La Grange, and which he imagines to be a compound of carbon, hydrogen and oxygen.

Distillation of Peat.

A quantity of this peat was carefully distilled, when a deep yellowish-brown coloured liquor was obtained: it had a strong empyreumatic smell, and, by exposure to the air, it acquired a considerable consistence. I did not examine particularly this liquor: I only found that, by the addition of quicklime, much ammonia was separated. Giroud, in the first volume of the Journal des Mines, mentions pretty fully the properties of this liquor. He finds that it is an ammoniacal soap; which, from the many experiments he made, he thinks, may become of considerable use: thus, the ammoniacal soap, being decomposed by sea salt, would form a cheap muriat of ammoniac, and the oily matter, by proper management, may answer for some purposes in the arts.

CARBONIZATION OF PEAT.

The late improvements in agriculture have pointed out a method of converting much of the peat, which is so abundantly spread over the Highlands, into a good and productive soil: yet still there is a great deal of it lost, not only in these operations, but also from its being situated where the labours of the farmer would be employed with little advantage. From these circumstances, it is certainly deserving of attention, to endeavour to discover some means of employing this waste vegetable matter; and thus to raise new sources of industry in parts of the country where there are now only extensive and dreary wastes, without an inhabitant. As the want of common coal and charcoal, in most parts of the Highlands, appears to have been the cause why many promising mineral appearances have been abandoned; I think that it is not improbable that charcoal, from peat, may, if carefully prepared, be used with common charcoal, or even by itself, in the working of ores. This is not an opinion founded upon mere speculation, for it has been actually put in practice in different parts of Europe: thus Baron Dietrich informs us that it is used in the Hartz for the smelting of iron ores. As the successful prosecution of this practice would be of much consequence to the Highlands of Scotland,

Scotland, I think it of importance to state shortly the different methods that have been followed to obtain a good charcoal from peat.

Two methods have been followed in these trials: the one, by exposing the peat to a smothering heat, as is practised in the making of charcoal from wood; the other, by exposing it to heat in close vessels or furnaces, and thus subjecting it to a kind of distillation.

So long ago as 1631, Lamberville † seems to have used the first process; but his attempts were not ultimately successful, as his charcoal was too friable; consequently, of no use in the forge, and other similar operations. In the Hartz, Dietrich observed that they carbonised the peat in large cylindrical iron vessels: but this was found to be too expensive; besides, the volatile matter, separated from the peat, was said greatly to injure the vessels. At Villeroi, in France, peat was carbonised by burning it in a furnace not unlike the common lime-kilns of this country: this method, like the other, was also found to be unprofitable. These different methods, as Ribacourt † remarks, are very objectionable; as they do not allow the watery, oily, volatile
and

† Journal des Mines, vol. 1.

and saline matters of the peat to separate, without, at the same time, consuming a portion of the carbonaceous matter, which causes a great diminution of the peat: besides this inconvenience, the peat is always irregularly burnt; one portion being in the state of charcoal, the other, with a considerable portion of the watery and other matters, not separated.

The second process, which is the subjecting the peat to a kind of distillation, seems from all the trials which have been made to be the most promising. Pfeiffer, in a work entitled, *Histoire de Charbon de terre et de la tourbe*, &c. published in 1777, describes a furnace, in which he distilled peat, and obtained a solid charcoal. Thorin, in 1791, obtained a recompence from the French government for a method of carbonizing peat in an improved iron furnace, by which he obtained a firm and useful charcoal. This method, however, was soon found to be unprofitable, on account of the great waste of the iron vessels by the fire, and the action of the volatile matters of the peat on them. More lately, Blavier † has published an account of a furnace, which is constructed of stone, and at little expence, and is said to answer excellently for the carbonization of peat; and, besides, it has this advantage, that all the
volatile,

† Journal des Mines, vol. 1.

volatile, oily, and alkaline, matters are easily collected. I at one time intended to give drawings of this furnace, but I am confident that the importance of this subject will lead the authors for the prize question, to make this the object of experimental enquiry. From this short account which I have given we have reason to suppose, that by the adoption of a furnace somewhat similar to that of Blavier, peat, at little expence, may be carbonized with advantage in the most remote corner of the Highlands.

Before leaving this subject, I will shortly mention the various trials that have been made with charcoal of peat, with a view of determining the difference between it and that obtained from wood. Sage* found that the charcoal of peat gave a stronger and longer continued heat than the charcoal of wood; and, further, that the charcoal of wood gives only a third of the heat of that of peat. Two furnaces of equal size, and in every other respect alike, were employed to melt a quantity of silver, when it was found that it required a greater quantity of charcoal of wood than that of peat to bring it into fusion. An experiment was also made in the great way at Paris to ascertain the utility of peat charcoal in the boiling of liquids,

* Journal de Physique, 1786.

quids, when it was here also found to have great advantages over that of wood. †

In metallurgic operations peat has been by some considered as very pernicious, while others find it not less useful than charcoal from wood. Dr Lind, in the Edinburgh Physical Essays, remarks, “ that there exists in peat an inflammable substance, “ which produces upon metals the same effect as sulphur, rendering them brittle. Another inconvenience which I have “ had the misfortune to experience is this, that a strong heat “ converts the charcoal of peat into a glassy substance, which “ collects along the sides of the furnace, obstructs it, stops up “ the passage by which the melted metal should run, and hinders it from collecting in the lower part of the furnace.” This observation, which seems very unfavourable for the employment of the charcoal of peat in the smelting of ores, probably deserves little credit; or if it be true, it only shews us that it is necessary that the nature of the peat should be known before it is employed, for, by its admixture with various extraneous matters, it may possibly become pernicious. That it is innoxious and useful, Dietrich has proved; and even Lamberville, in 1626, assures us that it was successfully used in the

† Journal des Mines, vol. 1.

the working of iron. More lately, experiments were made at Paris, when even the temper of steel was not in the least hurt by it. *

SOAP FROM PEAT.

I endeavoured in various ways to make a soap from peat, but always found that it gave a brown colour to the cloth. See *Nicholson's Journal*, Vol. III.

THEORY OF THE FORMATION OF PEAT.

The frequent occurrence of peat in many countries has naturally attracted the attention of philosophers, who have endeavoured to discover the mode of its formation. One class of observers have contented themselves by endeavouring to show that it is of vegetable origin, and have only differed as to the probability of wood, or moss alone, or jointly, having formed it; others again, having admitted its vegetable origin, differ only in the explanation of the means which nature uses

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* *Journal des Mines*, vol. i.

in the preservation of the vegetable remains. Lastly, it has been conjectured, that it is a *live vegetable, sui generis*; and an elegant poet having admitted its vegetable origin, has supposed some changes it undergoes by elutriation, &c.

There can be no question of the vegetable origin of this substance: any other opinion is but vain and frivolous: and, it is also inconsistent with fact, to assert, that either wood or moss singly are the only substances that form peat; for we know that in most cases they both contribute to its formation. In considering the peculiar state of preservation of the vegetable matter in peat, it is very generally believed that fallen wood, when it begins to putrify, produces an extract of the nature of tan, which preserves the moss that grows up among the trees, and converts it into peat. This opinion is founded upon the known action of astringent substances in preserving animal substances from decay; it will therefore be necessary to examine this process, to discover if it will help us to explain the phenomena of peat. It is but lately that we have had any probable explanation of the tanning process; and we are indebted to an excellent chemist, Seguin, for some interesting experiments and observations upon this subject.* He informs us,

* Journal of the Polytechnic School of France.

us, that oak bark, &c. contains two substances, the tanning principle, which has a great affinity for gluten, and the gallic acid, which has a powerful attraction for oxygen. When a solution of bark is applied to skins, he supposes that the gallic acid abstracts oxygen from the muscular fibre and reduces it to the state of gluten, when it immediately combines with the tanning principle, forming a compound, which is the cause of the indestructibility of leather. We have already shewn that peat does not contain the gallic acid; but, allowing that it does, it is impossible to conceive such an action to take place with regard to vegetable matters, particularly in peat, which I have found from experiment to contain no tanning principle. It will therefore be necessary to investigate the influence of vegetable acids, &c. upon vegetable matters, before any probable opinion of this kind can be formed.

The singularity of the appearance which peat presents, has led Dr Anderson to conclude, that it is a *live vegetable, sui generis*. This he imagines to be very satisfactorily proved, from the supposed impossibility of decaying vegetables possessing properties similar to peat. He remarks, "That in vegetables, " which have once fallen into a state of putrescency, their inflammability decreases in proportion as that putrescency " augments; and that their chemical qualities suffer an alter-

“ tion proportioned to the same circumstance. But by the
“ hypothesis of every person who supposes that sphagnum is
“ the original constituent matter of moss, it is always under-
“ stood that the foggy peat, by their hypothesis, is the sphag-
“ num still so little decayed, as not yet to have become per-
“ fect moss; and, that in process of time, it gradually be-
“ comes more and more perfect moss, as it gradually becomes
“ more thoroughly putrid, till at last, it loses even the appear-
“ ance of sphagnum, and becomes hard, and perfect peat;
“ that is to say, in other words, as it becomes more putrid, it
“ becomes more inflammable, which is directly the reverse of
“ the well known progress of nature in every other case.” It
is upon this and some similar arguments, that the Doctor re-
jects the opinion of moss being a collection of decaying vege-
table matters. But to these we may shortly answer, that de-
caying vegetables only lose their power of burning, with the
destruction of their carbonaceous matter; but this we know
requires a very long series of years, and when the vegetable
matters are in a moist situation, as is the case with peat, such
a decomposition may be prevented for hundreds of years.

The last theoretical opinion with regard to peat, which I
shall mention, is contained in a note of Dr Darwin's beautiful
poem, the Botanic Garden. He there gives us a truly strange
account

account of the changes which peat moss undergoes by elutriation, fermentation, and the consequent heat. As this is little else than a *dream*, it might be passed over; but it is detailed in the form of matter of fact, and therefore requires to be noticed. He remarks, "That morasses, in great length of time, undergo a variety of changes; first by elutriation, and afterwards by fermentation, and the consequent heat. By water perpetually oozing through them, the most soluble parts are washed away, as the essential salts; these, together with the salts from animal recrements, are carried down the rivers into the sea, where all of them seem to decompose each other, except the marine salt. Hence the ashes of peat contain no alkali; and are not used in the countries where peat is used as the fuel of the lower orders, for the purpose of washing linen. The second thing which is always seen oozing from morasses, is iron in solution, which produces chalybeate springs, from whence depositions of ochre and variety of iron ores. The third elutriation seems to consist of vegetable acid, which, by means unknown, is converted into all the other acids. 1st, Into marine and nitrous acids; 2d, into vitriolic acid, which is found in some morasses so plentifully, as to preserve the bodies of animals from putrefaction, which have been buried in them; and this acid, carried away by rains and dews, and meeting with calcareous earth, produces gypsum or alabaster, with

with clay it produces alum, and, deprived of its vital air, produces sulphur. 3d, Fluor acid, which being washed away, and meeting with calcareous earth, produces fluor or cubic spar. 4th, The siliceous acid, which seems to have been disseminated in great quantity, either by solution in water, or by solution in air, and appears to have produced the sand in the sea, uniting with calcareous earth previously dissolved in that element, from which have been afterwards formed some of the gritstone rocks, by means of a siliceous or calcareous cement. By its union with calcareous earth in the morasses, other strata of siliceous sand have been produced; and by the mixture of this earth with clay and lime arose the beds of marl." After this follow some whimsical notions about the formation of coal, which are connected with some supposed changes produced by fermentation and heat. We shall now, in as few words as possible, examine the truth of the supposed change by elutriation, which is all that interests us at present. As to the first position, that the salts are carried to the sea and decompose each other, we have no manner of probability, far less proof. The third stage of elutriation, where a vegetable acid makes its appearance, should have been confirmed by experiment; its supposed conversion into marine and nitrous acids is perfectly chimerical. I have not found sulphuric acid in peat, nor does Dr Darwin inform us that he had detected it;

it; therefore any reasoning founded on its action must be ideal.* The existence of the fluor acid in morasses, and the speculations about the filiceous acid, are all conjectures as odd, and improbable as could be contrived.

Having now mentioned the principal opinions with regard to the formation of peat; and having stated such objections as occurred to me; I will now endeavour to ascertain, upon chemical principles, the peculiar state of the vegetable matter when in the form of peat. In viewing the various phenomena of decaying vegetables, two distinct stages may be observed—

* “The common vitriolic acid, I believe, has never been found in nature, free from all combination, though it may unite with some bodies beyond the point of saturation. It is true, Mr Baltassari says, he found some dry concentrated vitriolic acid adhering to selenite, in a grotto in Monte Zaccolina, near Sienna; but this has been fully disproved by the subsequent observations of Mr Murray, in the 7th volume of the Memoirs of Stockholm, and of Mr Dolomieu, in his Notes upon Bergmann de Prod. Volcan. page 88.” *Kirwan's Mineralogy*, Vol. II. p. 2.

More lately, however, in the eighth volume of the *Bibliothèque Britannique*, we are informed, that, upon examining a water from Savoy, it was found to contain a considerable quantity of uncombined sulphuric acid.

ferred—the acetous and putrefactive fermentations. These processes are much modified by circumstances; depending upon the degree of heat, moisture, the presence of air, and the greater or longer continuance of the action of these agents. The putrefactive fermentation is the one which here claims our chief notice; for, attention to the appearances it presents will enable us to judge better of the state of vegetable matter in peat.

In the putrefactive process, if the heat be considerable, the destruction of the vegetable matter is soon accomplished: the whole is dissipated in the form of carbonic acid, carbonated hydrogen, and sometimes ammonia; a small portion of charcoal and ashes being left behind*. A more moderate degree of

* It is plain, that, in general, wherever carbonic acid and carbonated hydrogen gases are formed, both earthy and saline matters will be left behind; for carbon, which enters into the composition of these gases, contains neither earthy nor saline matters. This being admitted, we can account for the presence of saline matters in plants, without any great stretch of hypothesis. It has been discovered by Lampadius, professor of chemistry at Friburg, that charcoal decomposes water at the common temperature; and as all soils contain carbonaceous matter, it is plain, that, during the formation of these gases by the action of the sun's rays, a quantity of saline matter will be left in the soil for the use of vegetables.

of heat, with moisture, allows the matters to decompose more slowly, and to present the vegetable matter in several other intermediate stages, such as we observe with regard to peat when more or less decomposed. A very great proportion of moisture has a powerful influence in retarding this process: thus, the trees, which are found at the bottom of mosses, are fresher than those at the top, owing to the bottom containing a greater quantity of water; and the stakes, lately taken out of the Thames, are another remarkable instance of this.

From these circumstances, it is plain, that peat is a vegetable substance, which has undergone in part, and is still undergoing, the changes which have been just mentioned; and many facts lead me to conclude, that the common peat, or quick moss, is the vegetable matter, deprived of a considerable portion of its hydrogen. Not only the circumstances attending the situation and appearance of peat, but also other facts, render this opinion probable.

1. Sulphuric acid being added slowly to oils, and triturated, they gradually become brown, when the oil is rendered soluble in water and spirit of wine; but, if the acid be added in too great quantity, a black insoluble matter is formed.

2. If oleum animale be exposed to the action of oxygenous gas, water is formed, and carbon precipitated.

In this last experiment, we perceive, that the separation of hydrogen causes the precipitation of carbon: and, in the experiment with the sulphuric acid, we observe, that, in proportion as the hydrogen is dissipated, the carbonaceous basis becomes more or less soluble in water; and when the whole of the hydrogen disappears, a true carbon is left behind. In the same manner, with regard to peat, the woody, or other vegetable matters, are slowly deprived of a portion of their hydrogen, become brown, and somewhat soluble in water and spirit of wine; thus forming a kind of bituminous matter*. By a further decomposition, more hydrogen is separated, when the vegetable matter becomes insoluble in water, but still soluble in alkali; lastly, nearly the whole of the hydrogen is separated, when a black substance is left, what is called Peat Earth. This last, by exposure to the air, combines with a portion of oxygen, forming suberic acid; and appears to be what Lord Dundonald calls Oxygenated Peat.

* Vide Mr Hatchett's excellent paper on Bituminous Substances, inserted in the 4th volume of the Linnæan Transactions.

If this explanation be thought to have probability in its favour, we may explain some other facts in a pretty satisfactory manner. Thus the great Captain Cook remarks, that the coast of Tierra del Fuego is covered with peat-moss, and the water which runs from it has a brown turbid appearance. At one time, he was obliged to water upon this dreary spot, and could obtain no other water but that from the peat moss, which made him very suspicious of its good qualities, so that at first it was but sparingly used. Having soon got into the warmer regions of the Pacific Ocean, he found that this water deposited a small sediment, became pellucid, and was the most wholesome and freest from putrefaction of any he had on board. It is probable that the infusion of peat acted, in this case, in a similar manner with charcoal, (from which it differs but little,) by abstracting the putrescent matter. Another curious fact is mentioned by Dr. Plott—that intermittent fevers never occur in the neighbourhood of peat-mosses. This appears to be owing either to the slower decomposition of the organised matter in peat-mosses than in fens, by which a smaller portion of noxious gas is formed; or to the absorption of these gasses by the peat matter approaching to the state of charcoal. This last explanation is rendered the more probable from a well-known fact, that in church-yards, where a great number of dead bodies are buried, no bad smell is to be perceived; evidently

dently owing to the absorption of the noxious gasses, by the carbonaceous matter of the soil.

IMPROVEMENT OF MOSS LAND.

The method of improving peat moss, by means of calcareous earth, is certainly one of the most useful discoveries of the present day, and will, no doubt, form an important era in the annals of agriculture. Not long since, peat lands were only considered as useful on account of the fuel which they afforded. The case is now widely altered: the moss grounds are eagerly sought after: and, in the west of Scotland, this method of improvement is carried on with great spirit, and is repaying the judicious manager very amply. To give a detailed account of the methods which are followed, (and that is the only one that can properly be given,) would require a volume; and, after all, would be little more than a repetition of what is already known. I shall therefore content myself with endeavouring to apply the preceding experiments, to explain the mode of action of the calcareous earth.

We have already observed that peat contains the fuberique acid, or one nearly allied to it, which appears to be formed in greater quantity the longer the peat is exposed to the action of the

the air; thus assisting in retarding the decomposition of the peat, of course preventing its being useful in vegetation. Marle, shells and limestone are useful, in a triple capacity: in the first place, by removing the acid, the vegetable matter is allowed to decompose more rapidly; secondly, the combination of this acid with the lime, forms a compound, which may assist in vegetation; and, lastly, this acid having a stronger attraction for lime than the carbonic, will disengage it in considerable quantity, when it will assist vegetation.

I shall conclude, with remarking, that there is a considerable prejudice in favour of quicklime: if the explanation now given have any plausibility, it is plain that carbonat will answer as well, if not better, in the improvement of moss lands.

FROM

FROM BERNERA TO THE FRITH OF FORTH.

CHAP. XXV.

*Journey from BERNERA, by Fort-Augustus, Garvimore, Dalwhyn-
nie, Dalnacardoch, Blair in Athol, Dunkeld, and Perth, to
the Frith of FORTH.*

HAVING visited all the islands that lie immediately along the west coast of Scotland, from the Craig of Ailfa to the island of Skye; we agreed to defer, till another season, our expedition to the chain of islands that lie farther to the westward. We therefore left Armidale, in the island of Skye, and sailed up the found to Elean-reach, which is situated upon the mainland of Scotland. Here we landed, after a pleasant passage of three hours. The scenery, upon both sides of the found, was grand, and particularly about Loch-Houron. Though the mountains are peculiarly rugged and sterile, yet this rugged-
ness

ness was softened in the distance; and the airy tints of their summits, with the deep shadows on their base, marking strongly their vallies and furrowed sides, formed a beautiful mountain scene. As we passed the mouth of Loch-Houron, the day was serene; and the placid waters beautifully reflected the mountain skreens, which successively burst forth, and retired as we sailed along. The house of Mr Macleod is a sheltered retreat, almost hid among trees: it lies on the sea-shore, on the side of a grand amphitheatre of rocks, which opens to the sound of Skye. As our stay here was very short, I can say little with regard to its mineralogy; yet, from what I saw, I have little doubt that, upon attentive examination, many interesting appearances might be discovered. The rocks are entirely of primitive formation, and are composed of micaceous schistus, gneiss and hornblende-rock, and are traversed by great veins of granite. In several places, I observed great masses of lapis ollaris, which contained beautiful specimens of green actynolite, and green hornblende. We remained all night at this place, and in the morning set out on our journey homewards. We walked along the shore for about 2 miles to Bernera, where there are the remains of barracks that were built in this sequestered spot after the troubles in 1745. The rocks in this direction are still of the same nature with those at Elean-reach, but principally of gneiss. From this we entered into Glen-elg, which

which is an extensive valley bounded on both sides by great mountains. The lower part is cultivated, and vegetation is even observed covering the tops of the hills. The prevailing rock is micaceous schistus, but gneiss is sometimes to be observed in the higher parts; and both kinds of strata are traversed by granite veins. In our walk towards the upper part of the glen, I picked up several specimens of tremolit, which adhered to masses of quartz, and seemed to be derived from the strata or veins in the neighbouring mountains. Having reached nearly to the upper part of this glen, we ascended, by a broken military road, to the top of a hill, which seems to be principally composed of sienite. From this elevated point, we had a grand view of mountain scenery; vallies beautifully retiring, in misty colours, among screens of mountains, lightened with catching gleams: below us, appeared a pretty extensive loch, apparently surrounded by lofty mountains. We now descended to the side of the loch, by many windings down a very rugged and steep road, when we observed that the loch communicated with the sea, and its sides were adorned with gentlemen's seats. Although the scene was still beautiful, yet our ideas altered strangely, when, instead of the calm and cultivated retreat on the banks of an inland lake, we found an oozy bank, covered with slime and sea-weed, left by the retiring tide. The same sienite rock continues to the side of the loch; and

and from this to Ratachan Inn, which is situated at the upper part of the loch, the country is low, presenting strata of micaceous schistus.

As we were obliged to remain here the rest of the day, we examined slightly the hills in the vicinity. They rise to a great height, are bare and rugged toward their summits, and, so far as my examination went, appeared to be composed of micaceous schistus, which sometimes passes into gneiss, and is traversed by veins of granite.

We left the inn next morning before sun-rise, as we had to perform a long and dreary journey of nearly forty miles before the evening. Immediately after leaving the inn, we entered, by a narrow, abrupt pass, into Glen-Sheill. Tremendous mountains rose on each side, but, farther distant, all was dark and indistinct: it was but twilight; the obscurity thus thrown over the scene was peculiarly impressive. Before us, towards the head of the glen, the clouds were cleared away as the day advanced, and the opening, the modest, mellow tints of the morning cheered us with the prospect of a charming day for a journey through a country so dreary and wild. We were soon grievously disappointed: the clouds were seen rapidly covering the mountains; the ravines, situated near the summits,

mits, appeared white, from the water rushing over their rugged bottom; and soon the whole glen was obscured, and the rain poured down with great violence. We continued our disagreeable journey, which had but little diversity: only, now and then, a partial dispersion of the clouds allowed us to observe many grand, peaked mountains, rising to a tremendous height, far beyond the boundaries of the glen. At length, having reached far up the glen, we came to a narrow pass, where the waters were collected from the neighbouring mountains. They were precipitated over rude fragments of the rocks; and, swollen and pent up in a narrow channel, rushed impetuously forth until they gained the level bottom of the glen, where the river flowed "calm, sluggish, silent." Such scenes are the greatest ornament of the Scottish glens—where the stream, collected from the rude mountains, glides thro' the mossy wilds, and descends, by successive falls, thro' the rocks, shadowed by the overhanging woods, till gathering strength, "it boils, and wheels, and foams, and thunders thro." Indeed, in the course of this glen, we saw all the various beauties which a river displays in a wild and mountainous country. The tumultuous noise of the waters was reverberated from the neighbouring mountains, and continued to be heard long after we had lost sight of them. The road was now nearly impassable, torrents crossing it every few yards; which, in some places, were so rapid and

and deep, as to endanger our lives in crossing them: our guide having stumbled, with great difficulty saved himself. Having forded these torrents, we at length advanced into a more open part of the glen, where the road was better: here the storm began to abate; the clouds gradually rose; and in a few hours the sun again beamed upon us. When we looked back to the mountainous scene of Glen-Sheill, still obscured by dark clouds, it formed a striking contrast with the scene before us.

We now travelled, by a broken and winding road, to the side of a loch called Clouny, which is of considerable extent, and bounded on both sides by lofty mountains. On their lower parts, these mountains are skirted by natural wood. We walked along the side of this loch, to its farther extremity, which brought us nearly to the entrance of Glen-Morison. This glen is considerably different, in appearance, from Glen-Sheill: the hills which bound it are lower, and have much of the round-backed shape. We descended into this glen, and walked several miles, when we reached a dirty black house, called Unach Inn.

The country through which we had passed in coming from Ratachan inn, will afford much instruction to future travellers; but as my journey was rapid and attended with every

inconvenience, I can give but little information as to its peculiar nature. The mountains of Glensheill appear to be composed of micaceous schistus, which is sometimes alternated with hornblende slate, and veins of granite appear traversing these strata in various places. At Loch Clouny, however, the micaceous schistus disappears, when great hills of red granite are to be observed; and this rock seems to bound both sides of the loch, as is well marked, not only by the red colour of the debris along its banks, but also by the appearance of the broad flat faces, similar to what we observe in the great granite glen Rosa in the island of Arran. This granite continues for about a mile, when the micaceous schistus again makes its appearance; and near the junction of the granite and micaceous strata, great veins of granite are to be observed traversing the micaceous schistus, and several of the veins seem to issue from the granite itself. The greater part of these granite veins, however, have a different appearance from that of the great body of stratified granite, its constituent parts being of a great size. The micaceous schistus continues to Unach inn, but it is in several places alternated with hornblende-rock, and traversed by granite veins.

As the appearance of the granite veins shooting from the granitical strata into the micaceous schistus, &c. has been considered

considered by the late Dr Hutton as a proof of the posterior origin of granite to the strata which cover it; I think it necessary now to consider the plausibility of an opinion so contrary to that of the best informed geologists.

Dr Hutton maintains, "that all the solid strata of the earth have been consolidated by means of subterranean heat; softening the hard materials of these bodies; and that in many places these consolidated strata have been invaded by huge masses of fluid matter similar to lava, but for the most part perfectly distinguishable from it †." Granite he considers as a body which has been transfused in a fluid state from the subterranean regions, and made to break and invade the strata in the manner of basalt. His evidence for this opinion is as follows: He observed in the bed of the river Tilt, near to Blair in Athol, that the granite and schistus were much intermixed at their junction; and in the shire of Galloway and the island of Arran, veins of granite seemed to issue from the strata of granite and traverse the schistus; from this he concluded, as all veins are of a posterior origin to the strata which they traverse, that the veins of granite which traverse the schistus, being continuous with the granite, make the whole after formation

† Philosophical Transactions of the Royal Society of Edinburgh, Vol. III.

mation to the schistus. Many objections occur to this hypothesis, and I shall now mention a few of them.

1st, If granite had flowed from below, how does it happen that after it had burst through the strata of micaceous schistus, &c. it did not overflow the neighbouring country? If this hypothesis were true, Mont Blanc could never have existed.

2^d, If the granite had been forced up with the violence which Dr Hutton supposes, we should expect that the strata of micaceous schistus, or other strata that cover granite, should be invariably disturbed and broken in every direction, but more particularly at their junction. This is by no means the case; Saussure, Charpentier, and others, have examined vast tracts of granite country without observing such appearances; and in Scotland I have examined great tracts of granite, but the appearances described by Dr Hutton occurred rarely.

3^d, If all kinds of granite have been ejected from below, and if all veins of granite communicate with a central mass of granite, how shall we explain the appearance of granite veins in countries where no strata of granite have been observed? nay, where these veins have been traced from their beginning to
their

their termination in the shistus, a sufficient proof that they are not connected with any granite underneath?

4th, The general observation that the granite which runs in veins has a character different from that found in strata, intimates strongly that it has been found at a different period from the granite in strata.

These objections bear much against Dr Hutton's opinion, and may probably appear, in a considerable degree, to disprove it. I shall not stop here, however, but shall now mention a fact, which to me seems to remove in a considerable degree the doubts with respect to the connection of the granite with the other strata. The observations of Werner, Charpentier, Saussure, Reufs, and other geologists of the highest character, have demonstrated that granite, when it is covered by strata of gneiss, gradually acquires a shistose fracture, and at length is not to be distinguished from it; the gneiss, when covered by micaceous shistus, gradually passes into it by the loss of its felspar; and lastly, when ardesia, or primitive argillaceous shistus covers the micaceous shistus, a distinct gradation is to be observed by the disappearance of the quartz, and the increase of the argillaceous ingredient. Here then we have a demonstration that these different strata have been formed in
the

the same manner, and nearly at the same time ; therefore any speculations which refer to one of these kinds of strata are equally applicable to the others ; consequently the hypothesis of Dr Hutton is to be considered as unsatisfactory. The transition of these strata into each other is not an appearance confined to one country ; it has attracted the notice of geologists in all parts of the globe, and has been universally considered as a proof of the identity of the formation of these different strata. The appearance of the veins of granite shooting from the strata of granite into the schistus, may be explained in the same manner as common veins. Granite strata are frequently traversed by veins of granite, and these veins, although in general of a different grain from the rock through which they run, yet, in some instances, it is with great difficulty that we can distinguish them from the stratified rock. Now, as it is nearly demonstrated that granite, gneiss, micaceous schistus, and ardesia, are of the same formation, it is not at all improbable that rents would as readily extend through the gneiss and granite, as through the gneiss and micaceous schistus ; and that these rents would be afterwards filled up with granite similar to that of the strata, and thus form the appearance of the granite invading the schistus. The masses of granite enclosed in the schistus, and of schistus enclosed in the granite which are observed where

where the granite and shistus meet together have been explained in another part of the work.

I cannot leave this subject without mentioning that Dr Hutton asserts that granite is not stratified, and consequently that this is a proof that it has been formed at a different time and in a different manner from the other strata which cover it; and he applies the same reasoning to porphyry and basalt, which he says are not stratified. It is now well proved, however, as I have mentioned in a former part of the work, that granite is disposed in strata; and no one, I think, can doubt that porphyry and basalt occur in strata in many parts of the world. Indeed these are very common appearances. The ingenious Sir James Hall, a supporter of the Huttonian theory, remarks, that the mineral kingdom is divided into stratified and unstratified bodies, the latter comprehending granite, porphyry, and basalt*; but he understands by stratification, the flaty fracture of the stone. He is here in an error, as we have great mountains of shistose porphyry†;

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and

* Edinburgh Philosophical Transactions, Vol. III.

† Although porphyry, in general, does present a uniform and compact structure, yet, when it is quarried, it rises in large flat masses, or when broke by a hammer, it yields more easily in one direction than another; consequently it has the shistose structure, but in a less perfect degree than micaceous shistus or ardesia.

and shistose basalt || and granite, have been frequently observed.

Having rested a little at Unach inn, we set out for Fort Augustus. The road was first up a steep hill, which is composed of micaceous shistus alternating with hornblende slate, and traversed by granite veins. Having reached the top of the hill, we had a good view of Glen-Morrison nearly to its further extremity, bounded on both sides by grey hills, all apparently of a similar composition with that on which we were standing. We now walked pleasantly along for several miles through a muirland, when we came to a hill upon one side of the

|| Reufs observed, near to Teplitz, the top of a hill composed of basaltic columns; under these he observed basalt in very thin tables; and, lower down, the basalt was observed passing completely into shistose porphyry. He also observed the shistose basalt forming a vein, which traverses common sandstone. Reufs *Mineralogische Geographie von Boehmen*.—And Charpentier has observed granite decidedly shistose, and even where it had not externally the shistose texture, he found that it always broke in a certain direction, and when raised from the quarries, that it rises in great flat blocks; but it is only in a particular direction that these masses could be raised. At Aberdeen, where there are immense granite quarries, the workmen have the daily experience that the granite rises more easily in one direction than another, and also that in dressing it, their work is much hastened by breaking the stone in a particular direction.

the valley, in which Fort Augustus is situated. Below appeared the Fort, which has more the appearance of a mansion-house than a place of strength, but is charmingly situated upon the extremity of Loch Ness; and at a distance the great mountain of Ben-Nevis, the Mont Blanc of Scotland, was seen half wrapped in the clouds, which almost perpetually encircle its lofty summit. We now descended by a winding road over strata of micaceous schistus, traversed by granite veins, and in a little time reached a comfortable inn, which was the more agreeable after our long walk from Ratachan inn.

Having rested all night, we set out in the morning for Garvimore, preferring it to the route by Fort-William. The road continues for a considerable way to be very steep. It leads over a hill, which is composed of micaceous schistus, and is probably traversed by granite veins, as I remarked upon places of the road great masses of granite, that seem to have come from the neighbouring rocks. Having reached the summit, we walked for several miles among heathy mountains, composed principally of micaceous schistus, until we came to the foot of the mountain called Coriariach. We ascended it by a long, winding, tedious road of six miles: it was extremely dreary and desolate; not a human being, not a bird was to be seen; and the long bleached poles that are erected along the road to

direct the traveller during the snow had a singular appearance. From the summit, we had a very magnificent spectacle of the tremendous peaked mountains extending along the west coast of Scotland. This hill, and the neighbouring one, as far as I could judge, are entirely of primitive rock, and appear to be principally formed of different species of micaceous schistus. I observed upon the road masses of quartz of a nearly black colour, thus approaching in external character to the obsidian. Reuss, in his mineralogical history of Bohemia, informs us, that he found specimens of obsidian passing into quartz, and that he has in his possession a crystal, where the one half is obsidian, and the other quartz. These appearances observed by Reuss, as also the black quartz of Coriaraich, are probably no real gradation to obsidian, but merely quartz coloured deeply with iron or inflammable matter; the trial of its fusibility will help to determine this point. I also observed upon the top of the mountain fragments of compact felspar, which must either form veins traversing the strata, or alternate in the manner of strata; the latter supposition is the more probable. We now descended by a very zigzag and steep road, to the bottom of the mountain, when we entered into Glen-Drummond, through which runs the river Spey, having its origin in the neighbouring mountains. Many small heather-covered hills were scattered below the lofty precipices; and, upon examination

This image shows a blank, aged, cream-colored page, likely an endpaper or flyleaf from an old book. The paper is heavily stained with numerous brown, irregular spots and blotches of varying sizes, characteristic of foxing or water damage. The stains are distributed across the entire surface, with some areas appearing more heavily discolored than others. The overall texture of the paper appears slightly grainy and worn.



GRANITE VEINS TRAVERSING MICACEOUS SHISTUS GLEN DRUMMOND BADENOCH

ination, appeared to be formed of the debris washed from the mountains. We now continued our dreary journey through this desolate country. As we approached to Garvimore the strata of micaceous schistus were succeeded by considerable hills of granite, but these continue only for a little way, when micaceous schistus is again the prevailing rock, and continues to the inn at Garvimore. The micaceous schistus, however, is much traversed by veins of granite, which are from an inch to 12 feet wide. At the bridge which crosses the Spey, at a little distance from the inn, we observed in the bottom of the river a fine display of the granite veins, a small part of which is represented in the plate. These veins traverse the strata in various directions, and sometimes they appear to inclose masses of the micaceous schistus, as is well expressed in the engraving. In several of the blocks of granite that lie scattered about, I observed masses of micaceous schistus inclosed, and also in the masses of the micaceous schistus, pieces of granite were included. The hills in the neighbourhood of this house are of considerable height, and are generally composed of micaceous schistus, traversed with granite veins.

We left Garvimore by sun-rise; the morning was cool and pleasant, so that our journey was very agreeable. We walked for some time along the banks of the Spey, which are here included

cluded between great banks of boulder stones, that have been carried from the upper part of the glen. We soon left the banks of the river, and journeyed along by the foot of the hills that form the side of the valley; these hills are in general heath-clad, but often also present broken, rough, gray, surfaces, announcing them to be composed of micaceous schistus. This schistus appears in some places to be traversed by granite veins, as I observed upon the road masses of a granite, whose constituent parts are of great size, similar to that which is only to be found in veins. In some of the granite masses I observed pieces of micaceous schistus inclosed, similar to the appearance of the bridge near Garvimore. Having walked near to the further extremity of Glen-Drummond, we expected that we were near to Dalwhiny, the next stage, but to our mortification, we found that we had taken a wrong road, being near to Pitmain on the Inverness road; we were therefore obliged to walk back for about 12 miles, and did not reach Dalwhiny until the afternoon. The strata in this direction are still primitive, and composed of micaceous schistus; and, in the beds of the rivulets, I often remarked it traversed by granite veins.

Having refreshed ourselves after the long and circuitous walk from Garvimore, we set out for Dalnacardoch, as we wished to reach it before the close of the evening. The road
was

was good, and led through a valley bounded on both sides by lofty heath-clad hills, which are in general of micaceous schistus. Their shape is lumpish, with steep sides; and the strata are only to be seen where the rains have worn deep ravines, owing to the thick covering of heath. At a turn of the road, where we met with the river Carie, the strata are well exposed, but are still of micaceous schistus: but, upon the road, I remarked large masses of green hornblende, which approaches to actynolite; also, sienite, which is composed of white felspar, quartz, and hornblende: but I had not any leisure to determine their situation with regard to the other strata, as night was fast approaching, and we were happy to reach Dalnacardoch after our tiresome journey.

As the weather still continued extremely pleasing, we set out early in the morning for Blair in Athol, which is the next stage to Dalnacardoch. The road continued for several miles thro' a dreary country, similar to that which we had passed the preceding days, and the strata were not much different; micaceous schistus, in some places alternating with blue-coloured granularly-foliated limestone, being the prevalent rock. A few hundred yards before we enter into a birch wood that stretches near to Blair in Athol, I observed a large stratum of felspar porphyry? inclined at an angle of 45° , and resting on, and covered by,

strata

strata of micaceous schistus, which have a similar elevation. The stratum of porphyry, where I observed it, is from 12 to 15 feet wide; and is to be observed rising to the tops of the hills on both sides of the river; and, even at a distance, is easily distinguishable from the micaceous schistus, by its colour, and the peculiar manner in which it decomposes. As we approach to Blair, the banks of the river become lower; and in several places I observed porphyry, but it was sometimes difficult to determine whether it formed strata or veins. The mountains now recede, and range themselves on each side of the delightful valley which extends to Dunkeld: the banks of the river are skirted by natural wood, and to this immediately succeed lofty woods, that extend even to the summit of the hills. The country now increases in beauty every step; and we are led, by a delightful road, thro' a rich diversity of wood, to Blair, where there is a summer seat belonging to the Duke of Athol. The rapid change, from the brown, barren heaths of Dalnacardoch, to the richly-cultivated valley of Blair, is very striking to the traveller; and it is farther pleasing, from the probability that the other valleys, thro' which he has passed, may, one day, like the valley of Blair, attract admiration.

Having rested a little, we took the charming road which leads to Dunkeld, through a valley that is not to be exceeded
for

for the richness, or the variety and beauty of its scenery. The hills, which form the sides of the valley, are not of great height; and are, in general, formed of micaceous schistus, which has sometimes interspersed crystals of hornblende; yet there are also other rocks. Thus, a porphyry, similar to that which we have before observed between Dalnacardoch and Blair in Athol, appears to form a considerable hill among the micaceous schistus; but I regret that I had not leisure to examine their relative position. I also observed masses of sienite upon different parts of the road, and calcareous micaceous schistus. The micaceous schistus is sometimes to be observed passing into talcaceous schistus; and not unfrequently I observed crystals of hornblende shooting thro' it. At Dunkeld, the hills are of considerable height, and afford a considerable variety of rock; but I shall not at present stop to mention them particularly. I may only remark in general, that I found micaceous schistus; this is to be observed passing, by various steps, to chlorite schistus; and, lastly, the chlorite schistus is to be traced into ardesia. I also observed much quartz penetrated with the chlorite, in various proportions; and frequently I remarked a granular quartz rock, which has a basis of chlorite.*

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We

* As the country from Dunkeld to Dunbarton is frequently visited by strangers, I will in this note mention a few facts with respect to the general nature of the

We set out early in the morning for Perth; and on the road, at a little distance from Dunkeld, I examined a pretty extensive quarry of roof slate, (*ardefia tegularis*,) which is intermixed with chlorite, and beautiful specimens of micaceous iron ore.

I ob-

the rocks in that route. From Dunkeld to Taymouth the road is skirted by lofty mountains of micaceous schistus; and near to Taymouth there are quarries of talcaceous schistus, or lapis ollaris, which also afford fine specimens of asbestos. The rocks in the immediate vicinity of Taymouth are of micaceous schistus, but Mr Hatchett, with whom I made this journey, pointed out to me chlorite schistus passing into micaceous schistus, and the chlorite schistus approaching to lapis ollaris, and even making a passage into it. The micaceous schistus has frequently intermixed with it little rounded masses, having at first the appearance of garnets, but when cut with the knife, appear to be rounded pieces of the micaceous schistus. In the mountain we also picked up fragments of clay porphyry, but had not an opportunity of determining its situation with regard to the other rocks. From Taymouth along the banks of Loch Tay, the principal rock is micaceous schistus; and from the delightful retreat of Killin to the dreary and bleak Tyndrum we meet micaceous schistus, which is in some places stratified with limestone. At Tyndrum the mineralogist will be amused in examining the remains of the old lead mine. The next stages to Dalmally and Inveraray lead through a mountainous country composed of micaceous schistus, chlorite, &c. At Inveraray, there are quarries of lapis ollaris, and a considerable stratum of hornstone porphyry, and this porphyry is covered by a stratum of marble. From Inveraray to Carindow, the rocks are principally of micaceous schistus. At Carindow there is a beautiful kind of sienite, containing pretty considerable crystals of hornblende, and pink-coloured crystals of felspar. From Carindow to Ar-rochar,

I observed a breccia covering the micaceous shistus, thus announcing the termination of the primary strata; which we found to be the case. As the country now became much lower, its general appearance was quite changed; and to the strata of breccia, argillaceous sandstone succeeded.

I now took leave of the Highlands, where I had spent three months very actively; and have only to regret, that my little experience, and want of knowledge, in many important parts of mineralogy, may have caused me to over-

Z 2.

look

rochar, through the wild Glen Croe, the mountains are principally of micaceous shistus. From Arrochar to Lufs, which leads along the charming banks of Loch Lomond, micaceous shistus is the principal rock that occurs. Ben-Lomond, the highest mountain that rises from the side of the Loch, is composed of micaceous shistus on its lower part, but, towards the summit it is composed of gneifs. At Lufs, there is a quarry of ardesia or primitive argillaceous shistus; here Mr Hatchett pointed out to me the distinct gradation from indurated chlorite to chlorite slate, and from chlorite slate to ardesia. Masses of porphyry are to be seen in different places; and a rock, which is composed of rounded fragments of quartz, cemented by a basis of chlorite, lies scattered near to the quarry of ardesia. From Lufs to Dunbarton, we have not only a complete change in the appearance of the country, but also of the strata, as the primitive rocks near to Lufs are soon succeeded by the secondary sandstone, limestone, basalt, &c. which extend towards Dunbarton.

look interesting appearances, or to describe those, which I did observe, but imperfectly, and probably, in some instances, without sufficient accuracy. But, if after travellers shall experience as much pleasure in their journey as I did, they will have cause to think their time usefully employed.

The secondary strata, which are principally sandstone and basalt, continue to the flourishing and pleasant town of Perth. In the neighbourhood of the town, is the hill of Kinnoul, which is remarkable for the charming prospect from its summit, and the numerous beautiful pebbles of onxy, sardonxy, &c. which are found in a basis of indurated wacken.

From this, by Kinross, to North Queensferry, the country is entirely formed of secondary strata, as, sandstone, limestone, basalt, wacken, and greenstone; and in several places, as at Inverkeithing and St. David's, there are strata of coal, which are worked to a great extent.

A particular description of all this tract of country, from Dunkeld to the Frith of Forth, with an account of the coal
mines,

mines, would form a work that would afford much instruction and entertainment. The intelligent mineralogist would here have an opportunity of giving a minute description of an extensive Scottish coal-field, which would be an acquisition of much value to geology.

[I am happy to have it in my power to communicate to the public the following observations upon the mineralogy of the country between Fort-Augustus and Inverness, which were politely communicated to me by Lord Webb Seymour and Professor Playfair. In strict order, they should have been inserted in a preceding part of this chapter, but the sheet happened unluckily to be printed off before I was favoured with them.]

THE road, soon after it leaves the Fort, ascends, on the south side of the lake (Loch-Nefs), into an elevated, moorish tract, and continues on this high level for many miles.

For the first five or six miles, the rock is all micaceous schistus, with a considerable admixture of quartz.

Rising

Rising from this high level, there are several hills, along the sides of which the road passes: the valleys between are tolerably wooded. There are also a great many small lakes.

From about the point where the level begins to descend toward the east, the micaceous schistus ends, and a granitic sandstone begins, which continues for a mile or two.

The river Fyers rises on the right; and where the road first comes on the banks of it, you see micaceous schistus again, with a large dyke or vein of granite intersecting it.

We soon after come to granitelle, in great masses, some of it containing minute veins of much indurated steatites.

This kind of rock continues till near the uppermost of the two falls.

The high plain, in which we had been travelling all this while, is interesting, not only from its being on a level so much above other plains, but because the hills, that have their base in it, are of considerable beauty, as well as wildness, with valleys between them, abounding in pasturage, and interspersed with wood.

The

The Fyers runs, in the middle of the great valley, with much rapidity; the ground declines fast toward the E.; the bed of the torrent rocky, and the banks wild.

The vale of Fyers opens into a meadow between fine granite rocks, before you come to the first fall, which is above a little bridge.

At this fall, the rocks are all of granite. The whole scene striking and grand.

Below the bridge, which is close to the fall, you see marks of the wearing and scooping out of the granite rocks, 30 or 40 feet above the present level of the river.

About a mile farther down, is the great fall, by which the river descends at once to the level of the lake. This fall has been often described: it could scarcely be seen in a more favourable state than it was by us. The rock is still granite.

From the General's Hut, a mile eastward of the fall, the rock is granite; but is soon, on proceeding eastward, succeeded by a pudding stone, containing large rounded blocks
of

of reddish quartz and of granite shistus, united by a cement of sandstone.

This pudding-stone begins at the first torrent beyond the inn, which runs in a very deep channel, and exposes a fine section of the rock.

This pudding-stone accompanied us to near the end of the lake, when day-light forsook us, and prevented us from seeing distinctly the steps by which the highland country softens down into the plain.

The stones that we picked up on the road continued, however, to be primitive, all the way to Inverness. At Inverness, the same continues; and the freestone used in building is brought from quarries on the sea-shore not far from Elgin.

[It

SHETLAND ISLANDS.

[It is now several years since I wrote the following account of the SHETLAND ISLANDS. Since that time, I have been almost continually and actively employed in mineralogical pursuits; and have learned, at least, how very deficient this outline must appear. That knowledge of the subject, which enables a man to examine the mineralogy of a country with accuracy, is not merely the knowledge of fossils as specimens in a cabinet: it is to be gained only by an actual and very careful survey of different countries. This, I hope, will be my apology. I have republished this account, though imperfect, because these islands are remote, difficult of access, and interesting both to the geologist and the mineralogist.]

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SHETLAND ISLANDS.

CHAP. XXVI.

Outline of the MINERALOGY of the SHETLAND ISLANDS. General Observations. Mineralogy of the MAINLAND, FOULA, PAPA-STOUR, VEMENTRY, MUCKLE-RHOE, UNST, FETLAR, YELL, and WHALSEY.

THE Shetland Islands lie N. E. from Orkney, between lat. 59° and 61° . The nearest are distant, from Buchan-ness, 46 leagues; 16 or 18 leagues N. from the island of Sanda, one of the Orkney Islands; 6 or 7 leagues N. E. from the Fair Island; 58 leagues E. from the Faroe Islands, and nearly the same distance N. W. from the Lewis.

These islands are very numerous, but few of them are of any considerable magnitude: thirty-three are said to be inhabited, of which the largest is called the Mainland.

On

On a general view of these islands, a wonderful scene of rugged, bleak and barren rocks, presents itself. No tree, nor shrub, relieves the eye, in wandering over the dreary waste. Sometimes, however, a few scanty portions of cultivated ground catch the eye of the traveller, exciting emotions of pleasure, and forming a striking contrast with the barren heath-covered mountains which skirt them. The western part presents many scenes, wild and sterile as can well be conceived; where grey rocks, rising from the midst of marshes or pools, and shores bounded by awful sea-beat precipices, suggest to the mind ideas of desolation and danger.

The coasts are in general rugged and precipitous. Frequently the scenes are truly sublime: vast rocks, of various heights, dreadfully rugged and broken, oppose their rude fronts to all the fury of a tempestuous ocean; which in some places has formed great detached pillars, in others has excavated grand natural arches and caverns, that mock all human magnificence.

The east side of the Mainland (it is also the case in the other larger islands) is comparatively low; but the west is remarkably lofty, rugged and broken. Many of the mountains are sensibly more steep on the west, than on the east side. This

geological fact was long ago discovered by Dr Walker. It first occurred to him in the hills in the vicinity of Edinburgh; but he also found it to hold true in the Lomonds, and in all the other hills in the Highlands of Scotland. We also know that the west coasts of Scotland and of England have a gradual slope towards the east; and the course of all the great rivers, as the Spey, Tay, Tyne, Trent, and Thames, is from east to west. Upon examining other countries, the same phenomenon presents itself. Thus, the west coasts of Norway are precipitous, high and rocky. In the interior of Norway, the Lapland Alps present a precipitous west side, and the east shelves away, forming extensive plains. It is also very remarkable in the continent of America; where several of the largest rivers, as St. Laurence, La Plata and the Amazons run nearly from east to west.

Another observation may be made with regard to the hills—that they all run in the longest direction of the islands. This is a general fact, to be observed all over the globe. Thus, the mountains in Britain run from N. to S.; the Scandinavian mountains follow the same direction; as also the great ridges of the Norwegian and Swedish Alps. In America, the long-extended chain of the Andes runs from N. to S. which is the greatest length of the continent.

The

The hills in Shetland have seldom the strikingly rugged aspect of the island of Arran. They are greatly lower, and not so much worn by rains and torrents: the principal scenery of Shetland being produced by the action of the waves upon sea-coast.

The hills are generally round-backed, running in ridges: some approach to the conical shape, and are detached. None are remarkably high: the highest, which is Ronas Hill, is only about 1500 feet above the level of the sea.

To make general remarks upon the climate of a country, requires a long and careful series of observations, with a multiplicity of apparatus, which few have an opportunity of obtaining: and although a good deal may be done by means of careful observation with the thermometer and barometer, the proper use of these requires no common share of skill. To the exertions of the celebrated Mr Kirwan of Dublin, we are indebted for a great deal upon this subject. With the liberality which characterises a great mind, he has, at much expence, distributed meteorological instruments thro' Ireland; and we are now beginning to see the good effects of his endeavours. In this distant quarter of the globe, no accurate register of the weather has been kept; so that all I can do, will be, to make
a few

a few general observations, which apply pretty generally to all the northern isles of Britain.

The weather is extremely variable, there being a great deal of rain, and thick fogs, which occasion the loss of many vessels on these terrible shores. During the winter, there are considerable falls of snow, which lies, however, but a short time, on account of the vicinity of the sea. The frosts, which are seldom severe, and never long, produce little inconvenience: were they to continue for any considerable time, this situation, already sufficiently dreary, would be comfortless indeed. The thermometer has been observed 20° below the freezing point, but this continued for a very short time; a thaw soon followed, with hail, and violent gales of wind. Frequently, during the winter, dreadful storms prevail, particularly from the W. accompanied with thunder and lightning: an appearance seldom observed at that season in other parts of Britain.

Many instances might be mentioned, of the fatal effects, and extreme violence of the storms, which frequently happen among these islands; but I shall only mention one, which is still fresh in the memory of many.

During

During the three first days of January 1784, it blew a violent gale, and continued with increasing violence until eight o'clock in the evening of the third day. The storm was so furious, that the sea broke over headlands 120 feet high; and, at one place, a stone, computed at 12 tons weight, which lay ninety feet from the sea, was raised out of its place, and thrown two fathoms farther from the shore. Many vessels were wrecked, and vast quantities of fish thrown upon the shore. In the island of Moufa, I observed many great masses of sandstone, which had been torn off by the violence of the storm, and thrown far inland.

The aurora borealis, or what is usually called streamers, illuminates the sky with uncommon brilliancy, and helps greatly to alleviate the gloom of the long winter nights.

MAINLAND.

THIS is by far the largest of the Shetland Islands, being about seventy miles long, and from twenty to half a mile broad.

The

The cliffs around the whole island are very rugged, but more so on the west than on the east side; and the bays or voes, islands and rocks, are also more numerous on the west than on the east coast.

There are few mountains of any considerable height, being generally from a thousand to fifteen hundred feet high. Few of them are unconnected; but they generally run from N. to S. in the form of chains, having round-backed summits, approaching more or less to the conical form. Several considerable ridges can be traced along the whole of their course; and of these the most remarkable are the following:

1. *CLIFF HILLS.* This range commences opposite to the island of St. Rannens, where it is of considerable height, and runs by Scalloway to Deal-Voe, and from that to the sea, where it becomes gradually lower.

2. A range, which has no particular name, rises from West-shore, and runs, with little variation in height, S. W. and N. E. to Lunnefing, terminating on the sea-shore.

3. A range rises upon the east side of Weefdale-Voe from
Bunenefs,

Buneneſs, and runs from 16 to 18 miles, terminating on the ſouth ſide of Deal-Voe, in the pariſh of Delting.

4. The higheſt range riſes from the weſt ſide of Weefdale-Voe from Ruſtaneſs, and terminates at Friſkineſs in Delting.

The Mainland is divided into ſeveral pariſhes, ſome of them of conſiderable extent: the pariſh of Lerwick, which gives name to the principal village in the iſland, is the ſmalleſt. This village contains about 2000 inhabitants, and is built upon the ſhore of Braſſay Sound, which is near the middle of the iſland. The houſes in general are but indifferent; here and there, however, there are ſome commodious dwellings: and they are built of ſandſtone and ſandſtone breccia, forming one ſtreet, which is terminated by Fort-Charlotte. This fort was built during the time of Oliver Cromwell, and was for a long time in a ſtate of ruin, until lately that it has been repaired at great expence, and garrifoned by a corps under the command of a captain.

Braſſay Sound, which is the harbour of Lerwick, is one of the moſt extenſive and ſafe harbours in the Britiſh dominions; and has its name, and is formed in part by the iſland of Braſſay. This iſland is about 5 miles long, and between 2 and 3 broad, but very irregular in its ſhape. It is high and rugged

on the S. and E. where it is much exposed to the action of the sea; but it is comparatively low on the W. and N. where it forms part of the found. The highest hill, which is called the Ord of Brassay, forms, towards the sea, frightful precipices, several hundred feet high; all composed of sandstone, sandstone flag and breccia: and the whole island is composed of the same materials. A great mass has been separated from the east side by the violent action of the sea, and forms what is called the isle of Noss, remarkable for its tremendous cliffs and holm, where the natives encounter many dangers in fowling. This famous holm* is separated about 34 fathoms from the isle, and is perfectly mural on all sides, so as to present a most terrific aspect when viewed from below. Inaccessible as it appears, it has not prevented the daring islanders from gaining its summit, which exploit was performed many years ago, by a fearless fowler, who, having climbed to the top, drove stakes into the ground, and ropes being thrown around them from the opposite side, were fastened to corresponding stakes upon the bank of the island; a machine of wood, which they call

* Mr Pennant, in the elegant introduction to his Arctic Zoology, has given a drawing of Low's, which expresses the appearance of the holm very indifferently. The holm is said, by Mr Pennant, to be 480 feet in height: this is certainly too high.

call a *cradle*, was then fastened upon the ropes, so that it could be pulled backwards and forwards: and in this way they go in quest of the numberless sea-fowl that inhabit these cliffs. The fowler who first planted the stakes, flushed with his success, would not take advantage of the cradle, but, braving every aid, attempted to descend, and was dashed to pieces upon the rocks below. The island and the holm do not differ from Brassay in their composition; being formed of sandstone, sandstone flag, and breccia: but the sandstone is of various colours, a considerable extent of the cliffs being of a reddish hue.

The opposite side of the sound, where Lerwick is situated, is composed of the same sandstone and breccia which we observe at Brassay. The fort, already mentioned, forming one extremity of the town, is built upon a rock of breccia; which soon gives place to a horizontal stratum of sandstone, running to the opposite extremity of the town, called the Nab. The hills in the neighbourhood are not high, and are composed of sandstone and breccia. This sandstone is the same we observe in all the other parts of the island. The breccia is composed of fragments of red granite, micaceous shistus, quartz, felspar, and green mica: the fragments are either rounded or angular; of various sizes, from that of a grain, to masses of several hundred weight. The substramen, or basis,

is hardly discernible, excepting in large masses, when a paste is formed by the smaller fragments. I also observed, in general, that, where the fragments are large, the strata are distinguished with difficulty, and are horizontal; but as the particles become smaller, the strata are more distinct and inclined.

The coast, from Lerwick to Quarf, is composed of sandstone: in some places, however, there are great rocks of breccia, which have a very singular appearance, owing to the immense size of the concretions.

On this part of the coast there are several extensive caves. We rowed a considerable way into one of them, then landed, and walked to its farther extremity. At the entrance, it is a natural arch, which becomes gradually lower until it is lost in darkness, where nothing is to be heard but the dropping of water from the damp, black roofs, and now and then the silence is disturbed by the snorting of seals, or the flutter of the pelicans or columbæ. But the most beautiful part of these rocky scenes, is the wonderful transparency of the water, which discloses, to our view, rocks of various fantastic forms, covered with the beautiful millepora rubra, and adorned with fuci of a great variety of colours. These fuci, when moved by the gentle

the motion of the water, discover numerous species of spongiæ, actiniæ and echini, of the most exquisite colours, altogether forming an admirable submarine picture.

At Quarf, the island is only about two miles broad, forming the isthmus which connects the southern parishes with the mainland. It forms a kind of valley, which is bounded on both sides by mountains of considerable height, composed of micaceous schistus. Here, there is a small fishing station, from which boats go to the *Haafse*, or fishing ground, in search of tusk and ling.

The land from this again becomes broader, forming one side of Æthvoe, and is composed of sandstone, and breccia; in several places, however, there are considerable strata of limestone, which is worked for building and manuring the ground. This voe is a large open bay, having the flat and cliffs of Coningsburgh on the north and west, with Sandlodge, and Moufa on the south. The cliffs of Coningsburgh, which form part of the range of hills that rise opposite to St. Ranens, are composed of micaceous schistus; and in several places it is to be observed, with the common argillaceous sandstone covering it.

Among

Among the strata of micaceous shistus, I observed beautiful specimens of crystallised sienite.

Having passed these cliffs, we come to Sandlodge, one of the seats of the ancient and most hospitable family of Bruce of Sumburgh. It is situated upon the sea shore; having a pretty extensive flat near it. At a little distance from the shore, in the sandstone, which is here still continued, there is a vein of copper pyrites, or sulphuret of copper, which was worked for some time, by a party of miners, from Wales, with very flattering prospects; but the vein gradually decreased in width, until it was not above an inch broad, when it was thought proper to leave it †. On the opposite side of the house, there is another large vein of iron ore, above six feet wide, having a very scorified aspect. This was also worked for some time, but the great expence, and the small proportion of copper obtained, soon made it to be given up. The sandstone continues from this, all around to the bay of Sandwick, here and there intersected with calcareous spar, and much impregnated with oxyd of iron. Betwixt Sandlodge and Sandwick bay, lies the small island of Moufa, or Queen island, about

† I am happy to learn, that these mineral appearances have again attracted the attention of some Welsh miners, and they are now busy raising the ore.

which is about a mile and a half long, and upwards of a quarter of a mile broad. It is rather low, composed entirely of sandstone, and sandstone flag, with several strata of limestone, which run in the sandstone from east to west.

The whole coast from Sandwick to Sumburgh head, the most southern point of the island, is almost entirely composed of sandstone, and breccia, lying upon the mountains of gneiss and micaceous schistus, which run through this part of the island; there are also in several places considerable strata of limestone. From Sumburgh head, which is entirely composed of sandstone, we have an extensive and beautiful view of a great part of the Mainland, island of Brassay, and stupendous Noss; on the one hand the far distant Fair isle rises gently in the horizon, and on the other the secluded Fula forms a tremendous object. Below us we have a direful example of the blowing of loose sand, or what is called the *Sand Flood*; for an estate which belongs to Sinclair of Brue is now rendered a forlorn waste, which, before this calamity, was one of the most productive parts of the island. I could not learn the cause of this disaster, but it was probably owing to the tearing up some of the plants which are known to prevent the blowing of sand. This practice cannot be too severely reprobated, when it is known that the consequences are so pernicious; thus, in many of the Western

tern Islands Dr. Walker has observed, that if the smallest aperture be made in the sand, the flood instantly commences ; and we know that, in Suffolk, a quantity of sand, which at first only covered about ten acres, has now spread itself, and covers several thousand. The sowing of plants, which grow in loose sand, is the only remedy which can be recommended to stop the baneful progress of those floods. Of these several have been recommended ; but the most efficacious, are the *Galium luteum*, *Elymus arenarius*, *Triticum junceum*, and *Arundo arenaria* ; this last the Dutch plant with great benefit. From Sumburgh head across the large open Quendal bay, little is to be seen, except a few rocks of an extremely coarse breccia, of the common kind. At the next head-land, Fitful head, the primary mountains make their appearance, without any covering of the secondary breccia or sandstone, which disappears at one side of Quendal bay, and is not to be observed again until we come to Sandness hill on the north west part of the island. This immense head-land is almost entirely composed of a lead-coloured micaceous schistus, of which the greater part is mica, in very minute scales ; and in the fissures of the rock I observed several small portions of micaceous iron ore. The micaceous schistus is here to be observed passing to chlorite schistus, and intermixed with the talcite of Mr Kirwan, and considerable quantities of quartz. Below this at Garthness, there is a large
in-

vein of sulphuret of iron, about seven feet thick, running in a stone intermediate between micaceous shistus and chlorite shistus. It lies exposed to the day for twenty or thirty feet, and was worked for some time, but was also given up.

The coast from this all along the west side by Bigtoun to Scalloway, including Colfa isle, and the island of Saint Ranens, is composed of granite, micaceous shistus, chlorite shistus, talcite of Mr Kirwan and quartz.

The island of Saint Ranens is small, very rugged, and connected with the Mainland by a bank of decomposed micaceous shistus. Captain Preston, in his chart of the Shetland Islands, has placed this bank at one end of the island, in place of the middle. The coast from this to Cliff Sound is very rugged, owing to its exposure to the Atlantic Ocean; but in the Sound the land is defended by the islands of Houfe, Burra, and Trondray, and is neither rugged nor very abrupt.

The island of Houfe is about three miles long, narrow and flat, composed of micaceous shistus, granite and quartz. Near to the north end I observed a vein of granite two or three feet wide, running in the micaceous shistus; the granite had the

usual appearance, and where in contact with the stratified matter was not at all altered in hardness.

The island of Burra, which is separated from the island of Housa by a small sound, is also more rugged on the west, where it is much exposed to the action of the sea, and is composed of granite, micaceous schistus and quartz.

The coast and hills from Scalloway by Uistness Voe, Stromness Voe to Weefdale Voe, are composed of the usual alpine rocks. At Weefdale Voe there is a great stratum of limestone, which can be traced for several miles running in the micaceous schistus. All the hills in the neighbourhood are composed of micaceous schistus, talcite and gneiss; this last by decomposition forms a clay-like mass, which the inhabitants use for fullers earth. A great section of the gneiss is to be seen amongst these hills, in various stages of decomposition *. From Weefdale through Æthsting and Sandsting, the alpine rocks continue,

* The late Mr Wedgewood, upon analyzing an earthy substance from Sidney Cove, New Holland, was led from several circumstances to conclude, that it contained a new earth which he called Sydneia. Lately, however, Mr Hatchet, in a paper read to the Royal Society of London, [has] demonstrated, in a most

tinue, forming in many places considerable hills, and upon the sea-shore immense precipices of red granite. The scenery upon this coast is awfully grand; a great extent of coast, dreadfully rugged and broken, presents to our view vast detached pillars, and numberless magnificent arches, through which the tides rush with inconceivable fury, and the whole being tinged with a reddish hue, produces a grand effect, when contrasted with the lurid appearance of a stormy sky.

The next parish, which is named Walls, I had but little opportunity of examining, so that I can say nothing with certainty of its composition. In the neighbouring parish of Sandness, the sandstone again makes its appearance at Sandness hill, which is of considerable height. From this the coast becomes gradually lower, and is in many places peculiarly sterile and iron-like; the land again rises in height, and so on alternately all around the island, forming many considerable voes, with very magnificent pieces of scenery, particularly the Doreholm off the parish of North Maving, which is a vast detached rock, perforated by a great natural arch, very similar

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to

most satisfactory manner, that this supposed earth is a compound of filex, argil, and oxyd of iron; and he supposes that it is derived from a decomposed granite, or gneiss, similar to what has been mentioned above.

to some of those observed by Captain Cook among the South-Sea Islands. The immense rocks, the Ossa, Skerries, and Ram-na Stalks, present a most tremendous appearance in stormy weather: but to particularize the many rocky scenes that occur around this island, would be foreign to my present purpose. I shall therefore conclude this sketch, by remarking, that the rocks (so far as I have examined) are either granite, gneiss, micaceous schistus, chlorite schistus, limestone, or sandstone; but I did not observe this last in any quantity till we came to the east coast.

FOULA*.

THIS island is about three miles along, and half a mile broad, situated in the Atlantic Ocean, about twenty-four miles from
Main-

* As the Orkney Islands are visible from the heights of Foula in clear weather, there can be little doubt of its being the Ultima Thule of Tacitus: that of Pythias the Marseillian, who was contemporary with Aristotle, is thought, by Mr Pennant†, to be Iceland, while Dr Foster‡ is decidedly of opinion that it is some part of the Shetland Islands.

† Arctic Zoology, vol. i. p. lvii.

‡ Voyage to the North, p. 15, 30.

Mainland; holding the same situation with regard to Shetland, which St. Kilda does to the Hebrides. It contains but little level ground, being chiefly formed of three hills, of a nearly conical shape; the highest of these is between 800 and 900 feet in height. Here there is but one landing-place, and in bad weather it cannot be approached. The east side, which is much lower than the west is composed of granite, micaceous schistus, and quartz. The micaceous schistus covers the granite; but in some places the sea has washed it away, and left the granite exposed, which is of a red colour, and is frequently traversed with considerable veins of quartz. The micaceous schistus also contains nests of green actynolite, and garnets are often dispersed thro' it. The south, west, and north sides of the island are composed of sandstone, and sandstone flag, of the same species with that we have observed in the other parts of Shetland. Upon the west side there are most hideous precipices, inhabited by numberless sea-fowl, which the people run incredible risks in catching.

The account which Pontopiddan has given of the fowlers in Norway, is realized, and even exceeded by the inhabitants of this secluded spot. It is not many years since it was a common observation, that few died a natural death, being either drowned or dashed to pieces among these terrible precipices:

now

now they are more cautious, and comparatively few are destroyed.

PAPA-STOUR.

THIS island is of a very irregular shape, about a mile long, and half a mile broad, lying in the mouth of St. Magnus Bay, at a little distance from the shore of Mainland. It is low, but one of the most fertile of the Shetland Islands; and it has several tolerable harbours, of which Hamna Voe is the best: but the entry is difficult, on account of a great ridge of rocks, which runs across the entrance. At House Voe, which is the usual landing-place in coming from Mainland, sandstone, sandstone flag and breccia form one side of the voe, which is low, and not rugged. In going round the island toward the next harbour, called Olis Voe, the sandstone disappears, when a fossil, nearly similar to wacken, presents itself, forming cliffs of considerable height, without any marks of stratification; and it continues with little interruption all around the island, until it meets with the sandstone strata on the opposite side. From this, it appears, that these two genera of rock form the greater

greater part of the island. Several other fossils, however, are to be observed, either in strata below the wacken, in veins, or sporadic. Thus, upon the north side of the island, the wacken lies upon a kind of breccia, much resembling that of the Calton Hill, near Edinburgh. It is also traversed by veins of different kinds, which run in different directions, and vary considerably in their magnitude. The following are those which I observed. 1. Veins of greenstone and basalt: the basalt sometimes contains small crystals of fluor spar. The appearance of fluat of lime in basaltic rocks is rare; the only similar instance I am acquainted with, is detailed in the 6th volume of the Journal des Mines, where it is mentioned that grains of fluor spar had been observed in a basaltic rock. 2. Veins of semi-indurated steatites, which often contain hollow nodules of chalcedony and jasper, which are lined with crystals of quartz. 3. Veins of red sinople, which are intermixed with chalcedony and quartz.

I cannot dismiss this short account, without mentioning, that various species of pumice are to be gathered in several of the voes of this island, and some of the pieces are of very considerable size. Similar kinds of pumice are got near the Giant's Causeway, in Ireland, and upon the shores of the Western Islands, which volcanists have reckoned a very satisfactory proof

proof of their chimera. An examination of the rocks would soon satisfy any one but a volcanist that these were adventitious matters. Accordingly, their origin is now plainly traced from the famous island of Iceland; and this is rendered the more probable, when we consider, that many light substances are floated, from the West India Islands, upon the shores of the Shetland and Western Islands.

VEMENTRY.

THIS island is situated in St. Magnus Bay, at a considerable distance from Papa-stour. It is much intersected by the sea, and rises high in the middle, forming what is called the Wart of Vementry, upon the top of which there are the remains of a burgh. From this hill, we have a view of the whole island, and the adjacent coast of Mainland; than which nothing can be a more dreary prospect.

From the short time I was upon this island, I can only say, in general, that it appeared to be composed of granite, different

rent kinds of micaceous shistus, and a beautiful species of hornstone porphyry, which I observed in various stages of decomposition; in some specimens the felspar appeared to be decomposed first, in others the hornstone.

MUCKLE-RHOE.

THIS island is about twenty-four miles in circumference, the east and south sides are low, owing to their being defended from the violent action of the sea by the Mainland, but the west side is very rugged and broken. From the little opportunity I had of examining it, I can only say that a considerable part appeared to be composed of granite. Another island in the same bay, called Papa Little, appears to be composed of granite and micaceous shistus, of various kinds.

UNST.

THIS is the most northern of the Shetland islands; it is about eight miles long, and from two to two and a half miles broad. Its form is that of a lengthened square; the sea coast is as usual very rugged, and the island is hilly; the highest hill which is named Valley-field, is about seven hundred feet. There are two excellent harbours, Balta and Uyea Sound, which are often of the greatest service in sheltering vessels that pass to and from the Greenland seas; but the first is generally preferred as being more convenient and safe. Balta Sound is a pretty deep inlet, formed into an excellent harbour by the island of Balta that lies across its entrance, thus forming two passages; one from the north is rocky and only fit for small vessels, but the other from the south will allow large ships to enter.

The hills upon the north side of this sound are of considerable height, composed of serpentine, but present an extremely bleak and barren aspect, owing to the iron-brown covering, which it acquires by the action of the weather. The serpentine is of a green colour, is frequently traversed with small veins
of

of iron ore, and often assumes a fibrous appearance, forming what Wallerius calls talcite; a stone very different however from the talcite of Mr Kirwan. It also contains lamellar actynolite, labrador hornblende, tremolite, and veins of shistose talc traverse it.

This serpentine continues to form the hills and cliffs, until we arrive at the beautiful bay of Norwick, when a singular striated micaceous shistus takes its place, forming one side of the bay; this also constitutes a great part of the coast until a species of gneiss (remarkable for the large size of its crystals of felspar) makes its appearance, the micaceous shistus which covered it being washed away. Near to this place an immense mass has been separated from the land, forming a great hollow called Saxen Kettle, from the sea rushing through a narrow aperture at the bottom, which causes it to boil up with great violence.*

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* Here the Shetland Giant Saxe used to boil his prey, and terrify the affrighted natives; but more surprising than this is a famous well at a little distance, where the inhabitants say their ancestors used to get boiled or roasted fish, in proportion to the depth they went. This is a fact truly Plutonic, well deserving the attention of world makers.—*Brand's History of the Orkney and Shetland Islands.*

The land from this runs out to form what is called the point of Lambanefs, equally steep, but not so high as the sides of the bay, and from this to the Sha, the most northern point of the island, and of his Majesty's dominions, the gneiss continues, and does not disappear until we approach to the deep bay of Bura-firth, where the land becomes higher, forming lofty cliffs of micaceous schistus. At the bottom of this bay the land is low, presenting beautiful rocks of undulated micaceous schistus †; but after crossing the bay we find the land rise gradually, forming the lofty cliffs of Hermonefs, which are composed of similar rocks. At the bottom of these cliffs there are immense caves excavated by the sea, into which a boat can row many hundred feet in calm weather; the entrance is said to be ornamented with regular octagonal pillars, but what their nature is I could not determine, as the surf prevented me from approaching. Is it probable that they are formed of gneiss? for there is no other fossil near but micaceous schistus. From this the whole west coast is very lofty and rugged, composed of micaceous schistus, and this last often contains extremely beautiful regularly crystallized garnets of great

† This species is entirely composed of mica without any admixture of quartz, which Karsten in his catalogue of the Leskean cabinet reckons a rare production.

great size. As we approach the south west extremity, the land becomes lower, and towards Belmont, the seat of Thomas Mouat, Esq. of Garth, strata of ardesia, or primitive argillaceous schistus, are to be observed in the neighbourhood of the micaceous schistus. The serpentine now again makes its appearance, and forms in several places considerable hills, which have as usual a barren and bleak aspect. On the sea shore, between Uyea Sound and the castle of Mounis, there are strata of sandstone; and from this to Balta Sound the hills and shores are low, formed of micaceous schistus with a compound rock of green hornblende and quartz, and in some places we observe rocks of a compact felspar with hornblende.

F E T L A R.

THIS island is about four miles long, and three and a half broad, of an irregular shape, owing to its being much exposed to the action of the sea. Its mineral productions are not very different from those in Unst; indeed it is probable that at one time they were joined. There are no harbours of any consequence; the bay of Tresta is one of the largest, but is not safe
in

in stormy weather. One side of this bay is composed of micaceous schistus, quartz, in which large crystals of fluor are to be observed, with strata of alpine or primary limestone. On the opposite side of the bay there are appearances of plumbago; in one place particularly there is a vein of a matter resembling an impure plumbago, which is between two and three feet wide, running to all appearance in micaceous schistus. This latter fossil forms the coast for a considerable way. It however disappears, when immense cliffs of serpentine are to be observed, which often afford beautiful masses of rock crystal, also fine specimens of asbestos and amianthus. The serpentine, having formed a considerable extent of cliffs, disappears, when a curious species of micaceous schistus presents itself, composed of rounded masses of quartz, of considerable size, connected by means of mica, thus forming a rock not unlike to breccia. This rock, however, is only to be considered as a species of micaceous schistus, where the quartz masses are of a greater size than usual. Similar appearances, but not so striking, have been observed in other countries; thus the great road which traverses Moravia, is made, in the environs of Mark-Stannern, with a species of gneiss, which has disseminated globules of quartz, about half an inch in diameter †. This curious

† Journal des Mines, No. 23. p. 69.; from Trebra's catalogue of fossils.

rious rock forms a considerable extent of cliffs ; but at Strandburgh, a micaceous shistus, which seems passing to ardesia, takes its place. This micaceous shistus also forms a considerable extent of coast, which is low, presenting a most splendid appearance when the sun shines, his rays being reflected from the micaceous rock as from immense mirrors. As the coast rises, the serpentine again makes its appearance, having the usual brown, iron-like aspect, and forming lofty cliffs upon the shore ; but these continue only for a short way, when the micaceous shistus is again to be observed, and continues forming low cliffs to the house of Urie. From this, round to the bay of Tresta, the coast is lofty and precipitous, formed of micaceous shistus ; but at one place there are immense cliffs of gneiss, which, by decomposition, form a matter similar to that observed at Weefdale Voe, which is here also used as fullers earth.

Y E L L.

THIS island is about 4 miles from Mainland, is about 16 long, and 8 broad, and is, next to Mainland, the largest in Shetland.

Shetland. There are several harbours, but none of them large or commodious. It is in general pretty hilly, very much covered with peat mosses: this, with its tremendous broken coasts, renders the island wild and gloomy. The hills, as far as I could determine, are composed of granite, micaceous schistus, and quartz. On the west side, which is extremely broken and rugged, there are several veins of granite, about 5 or 6 feet wide, that run in the micaceous schistus. They are sometimes much curved, but generally run at an angle of about 70° . The granite is composed of quartz, felspar, and mica; but all these are larger than in the granite which is found in strata.

In several places I observed bitumen, sticking upon stones, or floating in small spring wells.

W H A L S E Y.

THIS island is about 6 miles long, and 4 broad, and is 3 miles distant from Mainland. The shores are low on both sides, and,

as

as far as I could observe, composed of micaceous shistus and granite. The highest hill is the Wart, which I found to be composed of micaceous shistus to the top.

At a considerable distance lie the Grief and Out-Skerries; dreary and desolate rocks, inhabited by a few fishermen, and composed of the same materials as Wharfey.

VOL. II.

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SHET-

SHETLAND ISLANDS.

C H A P. XXVII.

Description of the FOSSILS mentioned in the preceding Chapter.

CIANITE.

SAPPARE, Kirwan. BLAUER TALC, GLIMMER, SCHORL, Germanor.

Colour. White, finely tinged with azure blue. The detached crystals reflect a silver-white light.

Crystallization. Is crystallized in the form of compressed prisms, more or less feamed across. Presents two narrow, and slightly streaked, and two broad and smooth sides. The crystals are frequently disposed in a radiated form.

Cross Fracture. Striated, and destitute of lustre.

Longi-

Longitudinal Fracture. Foliated, with a lustre like that of crystals, or metals not much polished.

Hardness. When struck parallel to its length, yields difficultly to the knife; when perpendicular to its length, gives fire with steel: scratches glass.

Specific Gravity. 3.618.

Becomes electric by friction, and this electricity is negative.

Another species of this beautiful fossil was discovered many years ago at Botrephny in Banffshire, and it has since been discovered in various parts of Europe. Mr Werner thinks that it is nearly allied to the indurated talc, and that it makes an intermediate fossil between talc and hornblende.

WACKEN—*Papa-Stour.*

Colour. Brick-red of various shades, also dark-brown.

Lustre and Transparency. None.

Fracture. Smooth, earthy; but, when compact, it has a tendency to the fine splintery.

Fusibility. Melted at 120° of Wedgewood.

It frequently contains felspar, forming a species of porphyry; sometimes it is intermixed with green earth: it often also is cellular, and the cells are encrusted with dark-brown chalcedony, covered with crystallized quartz; and nodules of onyx and sardonix are sometimes found in it.

Common SERPENTINE*.

Colour. Blackish green.

Lustre. None, or faint glimmering.

Transparency. A little at the edges.

Fracture. Sometimes fine, sometimes coarse splintery.

Hardness. Yields with difficulty to the knife.

This fossil is used in many countries for the building of ovens, as it resists the action of the fire very much; and, when powdered and burnt along with potter's clay, it can be made into

* Werner has lately divided the Serpentine into two kinds, the Common and Noble Serpentine: the last mentioned has a conchoidal fracture, with a greater degree of lustre and transparency, and has generally a finer green colour than the first.

into light, solid vessels, which take a fine glazing, and resist the fire very well. In Italy it is used for the finest buildings. What the Italians call the Verde antico, is the noble serpentine mixed with marble or granular limestone.

Lamellar ACTYNOLITE—Kirwan.

This corresponds with the specimen I examined in the Lefkean cabinet at Dublin, from which Mr Kirwan's description is taken. It appears to be an intermediate fossil between actynolite, or strahlstein, and hornblende.

Common TREMOLIT.

ASBESTINITE, Kirwan.

Colour. Pale green.

Lustre. Silky.

Transparency. A little at the edges.

Fracture. Broad striated, the striæ frequently diverging as from a centre. Its fracture also presents distinct concretions, and it is from these that the striæ appear to diverge.

Hardness. Yields easily to the knife.

By decomposition it acquires an iron-brown colour.

Mr

Mr Kirwan found that this species melted into a green glass at 150° Wedgewood; and Klaproth has lately found, that, in a coal crucible, it gives a greyish-white, opaque slag, with the loss of 0.05; and in a clay crucible a compact greenish-white slag is formed. He finds that two parts contain,

Silex,	-	-	0.65
Lime,	-	-	0.18
Magnesia,	-	-	0.103
Carbonic acid and water	-	-	0.065
Oxyd of iron	-	-	0.005

The phosphorescence of the tremolit is very remarkable, and it has been found that the degree of effect is inversely as their hardness: thus the soft silky species gives a more vivid and red light, with a less degree of friction, than the harder kind. The phosphorescence can even be produced by means of a feather.

SCHILLER SPAR, or

LABRADOR HORNBLENDE.

This beautiful fossil is found in the serpentine rocks of the island of Unst. It was first discovered on the coast of Labrador;

dor; afterwards in Germany; and since in Cornwall, by Mr Hatchett. It is considered to be nearly allied to mica and talc; indeed it passes, on the one hand, into green mica, and, on the other, the yellow varieties pass into common talc.

M I C A

Is found in several of the Shetland Islands; and sometimes the plates are of considerable size; but they are not so large as those that I have seen brought from Russia. A considerable quantity of mica is used in the Russian navy, for the making of lanterns and cabin windows. It is preferred to glass, from its not breaking by the discharge of cannon. It has a considerable inconvenience, however, that it soon loses its transparency by the action of the air and sea-water.

As there are several fossils that have a very near resemblance to mica in their external appearance, I will here shortly state the characters by which they may be readily distinguished, as stated by the Abbé Huay*.

Mica

* Journal des Mines.

Mica is distinguished from talc, by its communicating, by rubbing, the resinous electricity to wax, while talc communicates the vitreous ; and farther, mica has not the unctuousity of talc. It is distinguished from cyanite, by its softness ; the cyanite being vastly harder. It may be confounded with sulphure of molybdæna ; but the sulphure of molybdæna soils paper, while mica does not : the same distinction with regard to carbure of iron. It is distinguished from the green crystallized uranite, by its pliability, the uranite being very fragile : the blow-pipe also affords a good distinction, the mica being converted into enamel, while the uranite is changed into a black scoria. The greyish-black mica may be confounded with the micaceous iron ore, or eisenman ; but the latter is friable, and adheres to the fingers, often acts on the magnet, and melts into a black scoria.

ORK-



ORKNEY ISLANDS.

C H A P. XXVIII.

Outline of the MINERALOGY of the ORKNEY ISLANDS; comprehending FLOTTA, SOUTH RONALDSHA, BURRA, POMONA, SHAPINSHA, STRONSA, SANDA, EDDA, WESTRA, EGLISHA, ROUSSA, and HOR.

HAVING, in my former journeys, traversed the greater part of the Scottish Isles, I was anxious to visit the Orkneys, and thus to make my tour more complete; and therefore, last summer, 1799, I embraced the opportunity of a vessel going to the island of Hoy, and sailed from Leith upon the 9th of June. The weather, however, proved stormy, and the wind contrary, so that we did not reach Orkney until the 20th, heartily tired of our voyage.

As soon as the vessel anchored, we landed upon the island of Hoy, immediately below the house of Mr Bremner, the minister of the parish, who received us very kindly. Having breakfasted, Mr Bremner was so good as to accompany us to the Berryhead, which is one of the most tremendous rocky precipices in Orkney. The walk was at first pretty easy; but as we came higher up the hill, it was fatiguing. Having reached to the summit of a high hill, we had still to ascend a considerable height, which brought us to the Berryhead. Here, indeed, a most sublime scene burst upon our view. Below us, and extending along the west coast of the island for several miles, were tremendous precipices of red-coloured sandstone, which rose to a great height. We crept towards the edge of the precipice, and beheld with terror a perpendicular descent of more than 1000 feet deep. When our attention could be withdrawn from the sight of these vast precipices, a scene of a different kind presented itself to our view. The sky was clear; the sea calm, and still as a lake; and the whole extent of the sea, and Pentland Frith, from Cape Wrath to Duncansbay Head, was before us: the wild mountains of Sutherland and Caithness, of an ethereal blue, added to the grandeur of the scene, retiring from the eye till at length they seemed to be blended with the ocean. We returned to the manse, well pleased with our excursion;

excursion; but found no variety of rock, sandstone being the only rock we observed.

We remained at Mr Bremner's all night, and took a boat next day for the island of South Ronaldsha; but, in our way, examined the small island of

F L O T T A.

THIS isle is of little extent, low, but in several places there are cliffs upon the sea-shore which are of considerable height. It is entirely composed of sandstone and sandstone flag; nor is it remarkable, excepting for its former celebrity, being the residence of the historiographer appointed by the crown of Norway to collect information with regard to the north of Scotland. These narrations formed a work called Codex Flotticensis; to which Torfæus is indebted for much of his history of the northern parts of Scotland.

We crossed from this isle to the island of

SOUTH RONALDSHA.

THIS island is about seven miles long, and one and a half broad. It is low, excepting upon the shores, where there are tremendous precipices, which have proved fatal to many an unfortunate mariner. The whole island is composed of sandstone, sandstone flag, and in some places shistose clay is to be seen. It appears, like all the other Orkney Isles, to have been formerly joined to Caithness, as the strata are similar. Mr Watson, the minister of the parish, told me, that the sandstone, in different parts of the island, has been dug, in expectation of finding good veins of lead ore (galena), but always without success. This is very probable, for Emmerling informs us that sandstone is very unfavourable to ores*. (Mineralogie, B. 3. S. 119.) In one part of the island we observed a stratum of shell marl lying under the peat, and in different parts of the island we observed bog-iron ore.

* It is said, however, that the mountain Verfopatal, in Mexico, is composed of sandstone, which is traversed by numerous veins, in which gold is found; Gerhard mentions similar rocks.

As the weather was boisterous, we remained in this island several days; at length the wind subsided, when we were enabled to cross to the island of

BURRA,

THIS island is of little extent, low, and composed of similar argillaceous sandstone with that of Ronaldsha; and in one place I observed strata of shistose clay alternating with it. The shistose clay is of a black colour, and has frequently interspersed bitumen; and veins of calcareous spar are to be observed traversing it. This is a favourable appearance for coal, and deserves to be tried.

As this island afforded nothing particularly interesting, we crossed to the Mainland, or what is called the island of

POMONA.

P O M O N A.

THIS island is about 22 miles long, and in some places about 20 broad. It is in general low; the hill of Wideford, near to Kirkwall, and those in the parish of Orphir, being the highest in the island. The shores in some parts of the island are pretty high, yet in general they are low. There are two good harbours: the one at the principal town, called Kirkwall; the other upon the opposite side of the island, at Stromness.

The mineralogy of this island is by no means interesting; the whole of the island, excepting a small portion near to Stromness, being entirely composed of sandstone, sandstone flag, shistose clay, and in one place limestone and basalt make their appearance. The strata are generally horizontal, and are of various breadths; and the sandstone and shistose clay alternate with each other. As it would be of little consequence to trace my steps in the walk which I made around this island, I shall mention only the peculiarities of the different rocks.

1. *Sandstone.* This rock is of various colours, grey, red, or whitish; has generally an argillaceous cement: yet, in particular kinds, this is but in small quantity. It is frequently shistose, forming sandstone flag. It is used for building in all parts of the island; and in some places, as at Skail, where it is very hard, being a filiceous sandstone, it is cut for millstones, and is said to answer the purpose very well. A stratum of filiceous sandstone, similar to that at Skail, I observed among the soft sandstone strata near to Scapa; and I have not the least doubt, if well quarried, that it would answer equally well for millstones*. Sometimes masses of iron pyrites, of a globular or irregular form, are dispersed through it; and of this.

* Different kinds of rock are used in Scotland for the making of millstones. Thus, in some places, as in the island of Raſay, I found porphyry used for millstones; and in Shetland, a compact species of micaceous shistus, is used for the same purpose. It has been a great desideratum to discover in Great Britain, a millstone equal to the French bur; indeed it is of such importance, that, the Society for the Improvement of Arts and Manufactures, at London, have offered a reward of 100 guineas, to him who shall discover a similar rock in Great Britain. As this rock may not be generally known, I think it proper here to mention that it is a cellular hornstone, and is found in vertical strata, according to Wallerius. As this famous stone is of a porous nature, and very hard; it is very probable that these properties must reside in all good millstones.—See Townson's Tracts, paper on Millstones.

this we have an example in the sandstone rocks upon the shore between Scapa and Orphir kirk. Trials have been made in the south part of the island with a view to find lead, but without success. At Yestneby, near to Skail, I observed veins of barytes traversing the sandstone; and, intermixed with this barytes, there was calcareous spar, iron pyrites and galena. At Skail, the sandstone, by the action of the weather, splits into many singular forms, similar to the sandstone I have described in the island of Arran.

2. *Shistose Clay*. This rock has a black colour; is always intermixed with mica; and passes, on the one hand, into sandstone slate, and, on the other, into clay, where the shistose character is more difficultly distinguishable. It acquires, by the action of the weather, an iron-brown covering; so that the rocks, at a distance, have much the appearance of the weathered serpentine rock in the islands of Unst and Fetlar, in the Shetland islands. In some places, as near to Stromness, I observed a red-coloured clay, which seemed to be clearly derived from the decomposing shistose clay. It is quarried to a considerable extent in different parts of the island, particularly near to Stromness, and the slates are used for roofing houses; but they are vastly inferior, in every respect, to the ardesia which is raised at Ballyhulish and Easdale.—Upon the sea-shore, near
to

to Brinnigar manse, which is about a mile from Stromness, in a kind of rock intermediate between shistose and indurated clay, there are many pieces of galena dispersed. Several years ago, a party of miners examined this appearance, and, having judged it probable that lead would be found in abundance, continued working for some time, but at length desisted, having, as they say, found it not worthy of farther labour. Near to the manse of Brinnigar, I observed masses of Lydian stone immersed in the shistose clay: in the Lydian stone there were several cavities filled with bitumen.

3. *Limestone.* At Yeskneby there is a considerable stratum of black-coloured limestone, which alternates with a rock intermediate between sandstone flag and shistose clay. It is much impregnated with bitumen, forming what is called stinkstein; and in several places I observed masses of bitumen dispersed through it.

4. *Basalt.* At Yeskneby is the only basaltic rock which I observed in the whole island. It forms veins, which traverse the common argillaceous sandstone. The crystals of hornblende, which are contained in it, are larger than usual in such rocks, being more than an inch long, and half an inch broad. I sometimes observed small cavities filled with bitumen.

The rocks of sandstone, shistose clay, &c. which I have just described, form the whole island, excepting an extent of a few miles around Stromness, which is of primary strata. These strata are, granite, gneiss, micaceous shistus, and hornblende rock; and all are traversed by veins of great-grained granite. The granite seems to form the central part, and is covered by gneiss, micaceous shistus and hornblende slate. At the mill water of Cairnston, which is not far from Stromness, I observed the junction of the primary with the secondary strata. The micaceous shistus is covered by a breccia which is composed of fragments of granite and quartz, cemented by a basis of smaller particles of the same rocks; and, in the breccia, I observed pieces of galena immersed. This breccia is to be observed, in some places, covered by the shistose clay. From some appearances in the neighbourhood of Brinnigar, it is not very improbable that the shistose clay may lie upon the primary rock, without any interposed stratum of breccia?

Having seen every thing that was worthy of notice, we crossed to the island of

SHAPINSHA.

THIS island is about 7 miles long, and 5 broad. The shores around the whole island are in general low.

The strata do not differ from those of Pomona; being principally composed of sandstone, sandstone flag, shistose clay, limestone, and basalt. The limestone is covered by a very hard, nearly siliceous sandstone, and it is also traversed by veins of the same sandstone. The basalt, which is only to be observed at the southern extremity of the island, seems to be covered with sandstone. In the sandstone isles of Copinsha, which lie at the southern extremity of the Mainland, or Pomona, I also observed a basalt, or rather wacken, traversed by veins of hornstone, and covered by a very hard sandstone: these, with the basalt veins at Yeskneby, are the only appearances of basalt which I have observed in the Orkney Islands.

As this island afforded nothing interesting, we sailed for the island of

STRONSA.

THIS island is about six miles and a half long, and six miles broad. It is low, but upon several parts of the coast there are cliffs of considerable height. The rocks are entirely of sandstone and sandstone flag; which latter sometimes passes to shistose clay.

Having spent two days in traversing this island, we crossed to the island of

SAND A.

THIS island is about 12 miles long, and in some places nearly 3 miles broad. Upon the western extremity there are hills about 300 feet high, but all the other parts of the island are low and flat. Large shoals extend a great way from the coast, which is one of the causes of so many vessels being wrecked upon this island.

The

The mineralogy, like that of all the other islands, is very uninteresting; it being, as far as I examined it, composed entirely of sandstone and shistose clay; excepting a rock of sandstone breccia, which I observed at a place called Hecla-bor: hence the rock has been considered as volcanic.

Having spent several days in traversing this island, we crossed to

E D D A.

THIS island is about 7 miles long, and in some places about 2 miles broad. It is hilly, and, like Sanda, entirely composed of sandstone, which is of a red colour.

We crossed from this to the island of

W E S.

WESTRAY,

and landed at the hospitable mansion of Mr Stewart of Brough. This island is about 9 miles long, and 6 broad. It rises, in some places, to a considerable height; and upon the north-west part of the sea-coast there is very magnificent rocky scenery. It is entirely composed of sandstone and sandstone flag; so that to a mineralogist it affords no variety.

PAPA-WESTRAY.

ABOUT two miles north from Westray, is the small, but pleasant isle of Papa-Westray. It is about three miles and a half long, and about a mile broad. It is principally composed of sandstone, sandstone flag, shistose clay, and in some places I observed fragments of breccia.

We now crossed, by a dangerous ferry, nine miles in breadth, called Westra Frith, to the small island of

GLISHAY,

where we were very kindly received by Capt. Baike. It is about two miles and a half long, and one broad; and is entirely composed of sandstone and sandstone flag, and in some places the strata seemed to be very much elevated.

As the weather was stormy, we could not leave this isle for several days: it having become more moderate, we crossed to the island of

RONSA Y.

THIS island is about four miles long, and three broad, and, excepting Hoy, is the most hilly of the Orkney Islands. The coast, in some places, is of great height, and presents many sublime rocky scenes. It affords no variety of fossils, being, like the other islands, entirely composed of sandstone and sandstone flag; which last sometimes passes to shistose clay.

Having

Having traversed the whole of this island, we crossed again to Pomona, and walked by Stromness, and again crossed to the island of

H O Y.

THIS island is about 12 miles long, and 5 broad; is the most mountainous of all the Orkney Islands; and its shores, as I have already remarked, rise, in many places, to a most terrific height. This island is remarkable for its excellent harbour, called the Long-Hope, where great fleets can rendezvous, and in complete safety.

This island is entirely composed of sandstone, sandstone flag, shistose clay, and in many places I observed a rock of wacken. The strata are generally horizontal, and sometimes they alternate. The sandstone has been dug, in various places, in search of iron ore; and the attempts seem to have been attended with some success, as rich hematitical iron ore was obtained. I am of opinion, however, that, in the trials which have been made

made near to Melfetter, upon the estate of Major Moodie, the proper bed of ore has not been fairly discovered; and that which has been obtained, is merely an admixture of sandstone and ore. In other countries, this admixture, of the ore and the stratified matter, has been taken for the true bed, and much unnecessary expence incurred, which might have been avoided by digging in a proper direction, so as to meet with the bed of ore. The shistose clay, where it alternates with the sandstone, has sometimes that shining appearance which is characteristic of the species found above, or in the vicinity of, coal strata: a circumstance which is to be considered as favourable for the discovery of coal in the lower parts of this island.

The wacken, which I have mentioned, is upon the sea-shore, at a little distance from Melfetter. It has, intermixed with it, calcareous spar, either in little veins or nodules: pieces of filicious sandstone are found in it, and even veins of a similar sandstone traverse it.

We now took leave of Major Moodie, and sailed down the harbour of Long Hope to the island of Ronaldsha, where we spent a few days very agreeably with Mr Watson, waiting favourable weather to cross the Pentland Frith.

ON K E L P.

CH A P. XXIX.

Observations on K E L P.

AS this substance is of the greatest importance to the Orkney Islands, I hope the following observations will not be considered as out of place.

This useful material does not appear to have been known as a manufacture in Britain, until some time after the beginning of the present century; owing to the backward state of the soap and glass manufactures, which, particularly in Scotland, have not been carried on with spirit above thirty years. It will not then surprise us, when we learn, that its first introduction

duction was about the year 1730, into the island of Uist, by a Highland gentleman, of the name of M'Leod, who brought the art from Ireland, where it had been carried on many years before. The method he followed was a bad one, as he was satisfied by merely reducing the sea-ware, or fuci, to ashes. This practice was soon discontinued, and the method of fusion was adopted. This manufacture soon found its way into all the other islands; for we find it forming an article of trade in Shetland, soon after its introduction into the Hebrides. The quantity of kelp, at first made, was trifling; but the great increase, and the rapid progress, of the manufactures depending on it, soon raised the price and increased the quantity: the following being, as far as I can collect, pretty nearly the price of kelp from the year 1740 to the present time.

From 1740 to 1760, average price about 2l. 5s. a ton.

1760 to 1770 - - - 4l. 4s. a ton.

1770 to 1780 - - - 5l. os. a ton.

1780 to 1790 - - - 6l. os. a ton.

Since the year 1791, its value has greatly increased, and has now risen to a greater height than was ever known before, owing to the war, which has prevented the importation of the

usual quantity of barilla, and has thus raised kelp to the enormous price of 11l. a ton *.

In Shetland, from 250 to 300 tons are made annually, but this quantity bears so small a proportion to the extent of the lands, as not to have affected the rent in an equal degree to that of Orkney; where, within these seven years past, small farms of about 40l. yearly rent, have risen to 300l. a year.

In Shetland, the cost of manufacturing is from 2l. to 2l. 10s. a ton; but in the west Highlands, the price of labour is greatly lower, being from 1l. to 1l. 10s. a ton. The method of manufacturing, though rude, is sufficiently simple. The different species of fuci, particularly the *vesiculosus*, *ferratus*, and *nodosus*, are cut from the rocks in the months of May, June, and July, and spread out and dried so as to enable them to burn more easily. In drying the ware, they are very cautious to prevent any fermentation from taking place, or to suffer it to be exposed to rain; as kelp, made from such damaged ware, is necessarily of a very inferior quality.

The

* Even this price might be still further increased in a very considerable degree, if proper methods of manufacturing the kelp were followed.

The ware being well dried, a small quantity is kindled in a pit dug in the sand, or upon a piece of ground which is surrounded with loose stones, so as to form what is called a kiln. They continue adding fresh quantities, until the pit or kiln is nearly filled, when the whole is frequently stirred towards the evening, when it gets into a semifluid state; it is allowed to cool, and afterwards taken out of the pit ready for the market. This method of burning the ware, is liable to many inconveniences. Of these, the following are not the least considerable:

1. As the sides of the kiln become heated, considerable masses of stone split off, and are mixed with the melted matter, which reduces the value of the kelp very much.
2. From the heat not being sufficiently confined, the ware is always very imperfectly burnt.
3. By the fusion being made upon the ground, a very considerable portion of siliceous earth is mixed with the melting materials; and this earth uniting with the alkali, renders a portion of it useless; because, though it increases the weight of the kelp, it deteriorates its quality.

These facts engaged the attention of my father some years ago, who endeavoured, by a series of experiments, to ascertain the value of kelp burnt in this rude way, and that made in furnaces. He erected several different kinds of furnaces, in which he burnt the ware, and afterwards examined the kelps; which were

were very solid; free of foreign earthy substances of masses of carbonaceous matter; and contained a greater quantity of alkali than common kelp—A recapitulation of all these experiments would be inconsistent with the intended brevity of this publication. I shall, therefore, only mention what he conceived to be the best form of a furnace.

It consists of one fire-place, covered with an arch, which communicates with four reverberating cavities, into which the ware is to be thrown. This fire-place, with a small quantity of fuel, produced a kelp of greater strength than any he had examined during his long practice; and, upon calculation, it was found that the expence of furnaces and fuel, was greatly more than repaid by the increased value of the kelp.

I find, that a special committee of the Highland Society, assisted by the late celebrated Dr. Black, had examined these furnaces, and reported to the Society their approbation of them. They also mention several other particulars, which are of importance to be more generally known.

“ Mr Jamefon further stated, that the expence of these kilns would be of moderate amount; that of the single 7l. or 8l. and of the four united, (which is the one I have described),
about

about 30l, with the addition of a small sum for a shade or cover, to protect the article when made, from the weather; but that such an expence would be repaid by the additional quantity of good kelp, produced from the sea weed, burnt into 10 tons; which the kilns would produce in a very short time, the single one burning one ton, and the quadruple four tons a day †."

Merchants, in their examination of kelps, are possessed of a few rules, which they generally follow, in determining their relative value; these are, taste, smell, colour, and compactness. These will give us a very vague idea of their value; and it requires no foresight to perceive, that trusting to external characters, in so heterogeneous a mass as kelp, must often lead the unwary buyer into a disagreeable predicament, in purchasing as good, what upon actual trial he finds of comparatively little value. These remarks are not idle conjectures; for I have often seen them verified, to the no small detriment of the manufacturer, and have as often regretted that so little attention should be paid to the ascertaining the proportion of alkali, &c.

Mr Kirwan of Dublin, whose active industry is now well known to all Europe, is the first who has engaged seriously in this

† Transactions of the Highland Society, Vol. 1. p. xxiv, xxv.

this investigation; and the results of his labours are detailed in the 3d vol. of the Transactions of the Royal Irish Academy.

Having favourable opportunities, through the good services of some of my friends, of procuring kelps and barillas, I ascertained the proportion of pure alkali in each of them: in some by the test of sulphat of argill, which is employed by Mr Kirwan; in others, by using an acid of known strength, the method recommended by Dr. Black.

*Table of the Proportion of ALKALI contained in different kinds of
BARILLA and KELP.*

	In the 100lb.
Barilla and Alicant—good	23½.
Teneriff—bad	8 lb. 7 oz. 120 gr.
Kelp from Norway indifferent	2 lb. 11 oz.
Shetland—indifferent	2 lb. 6 oz.
Lewis—indifferent	2 lb. 11 oz.
lbid—indifferent	2 lb. 6 oz.
West Highlands—much damaged	1-3d of lb.

Arran

Arran	-	-	-	3½ lb.
Isla—good	-	-	-	4 lb.
Mull—good	-	-	-	4½ lb.
Morven—good	-	-	-	4½ lb.
Island Skye—good	-	-	-	5 lb.
Leith shores	-	-	-	4 lb.

In judging of the value of kelp, it is not sufficient that we have ascertained the proportion of soda; several other circumstances must be attended to. In the first place, in judging of the value of a cargo, we must carefully examine its general appearance, which comprehends the size of the masses, the greater or less quantity of mixed stony matter, the degree of compactness, the proportion of diffused charcoal, the causticity, its wetness or dryness, &c. We then take pieces as different as possible from each other, and as expressive of the character of the whole as we can, pound them, and take any intermediate quantity, as an ounce, and ascertain the proportion of soda, which being done, will afford us as just an idea of its value, as from the nature of circumstances we can obtain.

Chemical Analysis of Fuci.

Our knowledge of the saline and earthy matters contained in fuci, is as yet very limited, which is to be regretted, when we consider the utility and importance of such an investigation. Bouvier, in the Annales des Chymie for 1791, has given us an analysis of what he names Fucus Helmenthorcoton. From his experiments, it appears, that no uncombined alkali is present, and that the principal saline compound is muriat of soda, (common salt.)

Vauquelin has found soda ready formed in some maritime plants. The plants which give most alkali by combustion, are not those that grow under the sea-water as fuci, but those that grow upon the land near to the shore, as *salsola kali*, *soda fativa*. The *salsola fativa* is the species which is cultivated in Spain for the making of barilla, and the exportation of the seeds is punished by death.

Cultivation of Fuci.

The cultivation of fuci upon shores, is now become an object of some consequence, not only from their value, as affording kelp, but also on account of their successful use as a manure.

nure. It has, therefore, been recommended to place stones upon the shores, which, in many places can be done at small expence; and these in two years, become covered with fuci, in such a state, as to admit of cutting. Various kinds of stones have been tried, as basalt, sandstone, and limestone; this last is by many reckoned the best, and, next to it, basalt.

CHAPTER XXX.

FROM

Journey from Hunt, upon the shore of the Pentland Firth, by
 Dornoch, Tain, Inverness, Fort-George, Nairn,
 Elgin, Liffemore, Cullen, Perth, Banff, Aberdeen,
 Dundee, to the Firth of Forth.

ALTHOUGH it required nearly six weeks to traverse the Orkney Islands, and that journey proved the most uninteresting I had ever made; yet I had the pleasing reflection of having examined a country, the mineralogy of which was before unknown, and of having now finished my journey thro' the greater part of the Scottish Isles. But I cannot leave them without acknowledging, in the warmest manner, my sense of the

FROM HUNA TO THE FRITH OF FORTH.

C H A P. XXX.

Journey from HUNA, upon the shore of the Pentland Frith, by Wick, Berrydale, Dornoch, Tain, Cromarty, Fort-George, Nairn, Forres, Elgin, Lossiemouth, Cullen, Portsoy, Banff, Aberdeen, Stonehaven, Dundee, to the Frith of FORTH.

ALTHO' it required nearly six weeks to traverse the Orkney Islands, and that journey proved the most uninteresting I had ever made; yet I had the pleasing reflection of having examined a country, the mineralogy of which was before unknown, and of having now finished my journey thro' the greater part of the Scottish Isles. But I cannot leave them, without acknowledging, in the warmest manner, my sense of
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the hospitality of the inhabitants : a kindness the more agreeable, that it seemed, on their part, to look for no return, and to proceed from feelings so consonant and natural, that they had forgot that it was unusual, and confined to those remote highlands, where the better feelings of the heart more freely expand themselves.

The weather being favourable, Mr Watson accompanied us to the ferry, which is at a place called Burwick, situated upon the south-west end of the island of South Ronaldsha. We bade him adieu, and left with regret a friend to whose kind attentions we had been so much indebted. Altho' the boat was excellent, we did not embark without some dread, from the recollection of the many terrible accidents which have happened in crossing the frith. Luckily the weather proved fine ; so that we landed at Huna, upon the coast of Caithness, after a passage of about two hours and a half. In crossing, we came close to the small, low island of Stroma, which appears to be composed of sandstone and sandstone flag : indeed we were informed that a great number of flags are annually quarried in this island, and carried to the coast of Caithness. At Huna, the shore is low, and is composed of coarse argillaceous sandstone ; and the coast and country, from Duncansbay Head to Dunnet Head, are evidently formed of similar rocks. As the postman was just setting out for Wick, which is the first town we meet with
in

in going southward, we embraced the opportunity of having him as a guide. The country continues low and flat, only in a few places varied by considerable hills; and cultivation seems very sparing. Near to Kies Castle we encountered a tedious sandy beach, over which we walked; and in several places we observed that the peat had been dug from under the sand. At the extremity of this beach, we passed a formal tower, a seat of Sir Benjamin Dunbar; and further on, towards the Noss Head, the castles of Guernigo and Sinclair were seen perched upon lofty sea-cliffs; and soon afterwards we came to the small borough town of Wick. The country, thro' which we had passed, is composed of sandstone and sandstone flag; but, in many places, I observed masses of breccia, composed of fragments of red granite, micaceous schistus, and quartz, cemented by an arenaceous basis: but I could not discover how it is connected with the other strata of the county.

Wick is the chief county town in Caithness; is of little extent; and lies upon the north-east side of what is called Wick river. The strata, upon both sides of the river, and in the neighbourhood of the town, are composed of sandstone flag, which is disposed in strata nearly horizontal; and, in the bed of the river, I also observed great masses of the breccia just mentioned.

We

We left Wick in the morning for the house of Berridale. We continued our journey for several miles thro' a heath-covered country, pretty level, but brown and bleak, with little cultivation, and no variety of strata; sandstone and sandstone flag being the only rocks. At Poakmaist the country is more hilly; and now and then the great mountains, the Paps of Caithness, and the lofty Morven, appeared at a considerable distance, forming a striking contrast with the low, mean-looking country thro' which we were passing. From Poakmaist to Dunbeath we had still the same bleak scene; and this tedious uniformity was only varied by the appearance of old, ruinous castles, perched upon the rocky cliffs on the sea-shore, or reclusive gentlemen's seats situated amid brown desert heaths.

After passing Dunbeath, we continued walking for about four miles, along the sea-shore, thro' a heath-covered country, when we came upon the side of a valley beautifully covered with natural wood; and we observed, situated in its bottom, the neat inn of Berridale, for which travellers have to thank the generosity of Sir John Sinclair. As we descended, by a winding road, to the house, the valley became more reclusive: the distant mountains being hid by the sides of the valley, and a bridge thrown across a water which runs over a broken channel overhung with natural wood, added much to its beauty.

This

This is indeed a scene that might be admired under a milder climate. The strata, from Dunbeath to this valley, are formed of sandstone, sandstone flag, and a blue species of secondary ardania: the higher grounds appear to be entirely of primitive rocks.

As the weather was delightful, we did not proceed on our journey homewards, but next morning we agreed to ascend the mountains in the neighbourhood, so that we might obtain some information as to the structure and composition of the high parts of the country. After breakfast, we took a winding and pretty steep road upon the south side of the valley, which led thro' the natural wood, and soon reached the summit of the valley. From this, we had a fine view of Morven, Scuraben, and the neighbouring mountains; yet we were separated from them by a long, dreary peat muir. Having crossed the muir, which was very fatiguing, (owing to its broken surface,) we at length reached the bottom of Scuraben. We here found a tolerable tract, which led us a considerable way up the mountain. At the termination of this tract, we turned westward, and walked over a wilderness of stones, and thro' a thick fog, to the summit of the mountain of Scuraben. The thick mist entirely prevented us from seeing the neighbouring country; and we were forced to descend into a hollow
upon

upon the lea side of the mountain, to shelter ourselves from the piercing cold and drizzling rain. We laid ourselves down behind a great mass of rock, anxiously waiting for the dispersion of the fog; and, being much fatigued, fell asleep, but awaked soon afterwards, cold and wet, and still involved in a thick mist. As our situation was now by no means agreeable, we quitted the hollow in which we had taken shelter, and descended by the north-west side of the mountain, and, after a long walk, we were happy again to reach the sweet retreat of Berridale.

From the observations which I made upon the summit of the hill, and in the ascent, the following appears to be the nature of the strata. The lower part of the country is common argillaceous sandstone, and sand sandstone flag; but, as we ascend, the next rock is an arenaceous breccia, which has, immersed in it, fragments, of various sizes and shapes, of red granite, micaceous schistus, and quartz; and to this succeeds a rock of quartz, which reaches to the summit of the mountain. This quartz is sometimes so intermixed with the mica, as to form micaceous schistus; and very often it has a brecciated appearance. Moreover, with the other neighbouring mountains, from their white colour, appear to be composed of a similar quartz rock. It would be an object well worthy the attention of the mineralo-

gift, to examine the junction of this quartzzy rock with the sandstone strata, and also to determine with accuracy the angle of elevation, &c. of these strata.

Having rested after the fatigues of our journey to Scuraben, we left Berridale early in the morning. The weather was charming; and the perfume of the wild flowers, which was diffused all around, rendered the beginning of our journey very agreeable. We ascended first by a steep, winding road, which was covered with masses of sandstone breccia; and considerable blocks of granite and micaceous shistus lay scattered upon the road. From this, to the valley which is formed upon one side of the Ord of Caithness, the same strata continues: that is, upon the sea-shore, red argillaceous sandstone; and, farther up, sandstone breccia, which contains fragments of granite, micaceous shistus, and quartz, immersed in an arenaceous basis; and to this succeed the primitive strata. As we descended into this valley, we observed the road covered with great masses of granite; and the hills above (which are heath-covered) appeared also to be formed of granite.

We now ascended from this valley by the steep mountain called the Ord of Caithness, and, after a fatiguing walk, we reached the narrow pass which forms the entrance into Suther-

landshire

landshire from the north. Before, were the distant mountains of Ross and Inverness shires; but, below, was the sea-coast of Sutherland, which had a singular appearance: the cultivated ground forming a low and nearly level bank, which is skirted by dark mountains of a considerable height. The pass itself was bounded upon one side by a steep mountain of granite †; on the other, was a frightful precipice hanging into the sea, and composed of a species of breccia, which, as far as my short time would allow me to determine, seems to lie upon the granite. We now descended, by a winding road, to the bank we have just mentioned, and walked along it to a village called Helmsdale, where unluckily we could get little to satisfy our craving hunger. This village, or kraal, is situated in a valley of considerable magnitude, and is bounded on both sides by mountains of granite. We now crossed the water of Helmsdale, and walked along the shore, by the side of the bank which is continued from Helmsdale, to a dirty hut, which passes for an inn, and is called Wilk House. This bank is composed of strata of red and white-coloured sandstone; but upon the shore, at a little distance from this sandstone, there are low, shelving rocks, of an argillaceous breccia, which is composed of fragments of sandstone and quartz immersed in an argillaceous breccia. These secondary strata are bounded by higher mountains, which are primitive, and probably of granite.

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† This granite is compact, and composed of felspar and quartz.

After leaving Wilk house, the bank, which had accompanied us from the Ord of Caithness, was now succeeded by flat ground; but our general course was thro' sandy beaches: and this, with the great heat of the day, rendered our journey very fatiguing. As we approached near to Dunrobin Castle, the fine feat of the Countess of Sutherland, the country becomes wooded; and at length we observed the castle rising with much dignity among the fine wood with which it is so richly ornamented. Soon afterwards, we reached the kirk of Golspie. Having rested a little, we continued our journey over a flat sandy tract of country, which is bounded by high primitive mountains. About three miles from Golspie, we came to a river, and were here detained for nearly an hour until the obstinate boatmen would ferry us across; and then walked among sand banks, and over heath muirs, to Dornoch, where we arrived in the evening, completely fatigued, after a walk of nearly 20 hours. I was a good deal surprised to meet with many pieces of pumice stone among the sand banks between Golspie and Dornoch: these have assuredly been driven on shore from the sea, as I have already mentioned to be the case with regard to the pumice found upon the shores of the Shetland Islands.

Dornoch is an old, desolate-looking town, only remarkable for the ruins of its cathedral.

We

We left Dornoch in the morning, for the village of Tain. The road to the ferry, which is upon the north side of the frith of Dornoch, is thro' a low, level, and pleasant country. It is in many places well cultivated, and ornamented with wood, that extends to a considerable height upon some of the hills bounding the low country. The strata of the lower parts are of red sandstone; and I observed many fragments of micaceous schistus, and granite, which have been washed from the neighbouring mountains. We now crossed the ferry, which is about three quarters of a mile broad. In our passage, looking downwards, we had a pretty extensive view of the low sandy country on both sides of the frith; a prospect not unlike the views we have on many of the low shores on the English coast. The view upwards was of a very different kind: it was the wild and rugged mountains of Ross-shire, which in some places appeared white with snow, in others richly covered with wood. The road from this to Tain led first thro' a sweet flat adorned with broom; then along a road bounded by trees; and the scene was again varied, before we reached the town, by a disagreeable tract of heathy and sandy ground. The strata, in this tract, appeared to be principally red-coloured argillaceous sandstone: but, as we approached the town of Tain, I observed considerable masses of granitic porphyry, gneiss, micaceous schistus, and hornblende schistus. Whether all these

rocks

rocks form strata in the neighbouring hills, or are only masses derived from a breccia which I observed lying upon different parts of the road, I had not an opportunity of determining.

After dinner, we walked to the ferry of Cromarty. The road led thro' a pretty flat country, and the strata seemed to be entirely of red-coloured argillaceous sandstone; and, in several places, I observed great masses of breccia, which is formed of fragments of granite, gneifs, micaceous schistus, hornblende rock, and quartz. We now crossed a ferry, of about one mile and a half broad, to the town of Cromarty. This is a neat highland town, and is much beautified by the fine grounds and handsome seat of the Earls of Cromarty. The prevailing strata in the neighbourhood of this town, and what forms both sides of the entrance of the Cromarty frith, is a red-coloured argillaceous sandstone.

We left Cromarty early in the morning, for Fort-George. The country is, all the way, pretty flat. We could not observe the strata, owing to the covering of heath, until we came near to Fortrose; but in several places I observed masses of granite, gneifs, micaceous schistus, hornblende rock, and also masses of arenaceous breccia. As we descended to Fortrose, strata of arenaceous breccia made its appearance; and the coast
of

of the Murray frith, from Fortrose to the entrance of the Cromarty frith, seemed to be composed of red-coloured argillaceous sandstone, with strata of arenaceous breccia. We now walked down to the ferry-place, and crossed the frith, which is about two miles broad, to Fort-George. This fort, the most complete piece of fortification in Great Britain, is situated upon a low point of land which juts across the Murray frith, and is built of red and white-coloured argillaceous sandstone. From it, we have a fine view of the frith, which expands beyond the fort, and is bounded by lofty hills; and this prospect is terminated by the capital of the highlands, the picturesque town of Inverness, with great mountains rising on both sides of it.

If we look at the map, we shall observe that Scotland is deeply indented both on its east and west side. In the east, the spacious Murray frith intersects the country as far up as Inverness; while, upon the west side, Linnhe Loch reaches to Fort-William. A great valley, about 60 miles long, extends between these arms of the sea: it is bounded by lofty mountains; and its bottom is covered, excepting for about 17 miles, with deep lakes. The land between the lakes is level, and composed entirely of alluvial strata, excepting some rocks to the south-west of Fort-Augustus†. It has been proposed to connect the lakes by
a canal,

† Transactions of the Highland Society, vol. ii.

a canal, and thus to save the tedious and dangerous passage by the Pentland frith; and, as the ground is level and soft, the expence would not be very great. This plan has much plausibility; yet it would be more likely to meet with attention, if the mineralogy of the great glen was carefully examined. It is not improbable that promising appearances of ore may be discovered; and these, if worked with spirit, would employ many hands, and render a canal of vastly more importance. The few satisfactory mineralogical observations which have been made on this glen, have not been made with a view of discovering veins or beds of ore; so that we are, as yet, entirely ignorant of the mineral treasures which it may contain.

We left Fort-George. The road led thro' a low, heathy country. On one hand was a sandy flat, partly overgrown with heath, which seemed to have been formely covered by the sea: on the other was a heathy country, and at a distance hills. I observed, upon the road, masses of granite, micaceous schistus, quartz, and sandstone. The sandstone strata, which I observed cropping near to Nairn, seem to form the level part of the country; but the hilly part, from its general appearance, and the masses of micaceous schistus which are scattered about, seem to be of primitive rock.

We

We dined at Nairn, and set out for Forres. At a little distance from the town, we observed great sand hills, and a terrible sandy coast stretching towards the ocean. This scene was very striking: the whole sky was covered with dark clouds; yet the whiteness of the sand caused the light to be so strongly reflected, particularly from the hills, that they appeared as if the sun was shining upon them. We stopt to examine them, and found that they were composed of fine white sand, which does not lie in beds, but is irregularly heaped: a circumstance sufficiently conclusive that these accumulations have been produced by the blowing of the sand. The whole of the neighbouring country is much covered with sand, and some great estates have been almost destroyed by this sand flood. We now continued our journey; and as we retired from the sand hills, their appearance became the more striking, as every object was clothed in a sable hue, while their bright surfaces at length shone like luminous points upon the horizon. The road continues for a considerable way through a bleak country, but as we approach to the pleasant town of Forres it assumes a rich and lovely aspect. The strata, all the way, are decidedly secondary, being of sandstone and basalt; but the rocks in the higher parts of the country are probably of primitive rock, as is intimated by the fragments of granite and micaceous schistus which lie scattered about.

Forres is a neat, well-built town, pleasantly situated between two little hills; but we could not enjoy the pleasure of examining it more at leisure, as the evening was at a close: and we were forced to proceed to Elgin, a distance of 12 miles. At a little distance from Forres, we examined, in the twilight, the famous pillar mentioned by Mr Pennant; and then continued our journey to Elgin in the dark. In the middle of the night, we crossed the blasted heath on which the weird sisters met Macbeth in the day of his success, and stopt him with their prophetic greeting. The solitary hour of the night, the melancholy noise of the wind rushing across the heath, the glimmering of the Will-o'-the-wisp, excited in us that strange feeling of superstitious alarm of which every man must at some time or other have been conscious.

Although much fatigued with our long journey from Cromarty to Elgin, we rose up early in the morning, and examined the magnificent ruins of Elgin cathedral.

We now continued our journey from Elgin towards Lossiemouth, which is situated upon the sea-coast. The country, for a short way, was very pleasing; but having reached an eminence above the town, we descended into a flat, indifferently-cultivated country. As we approached Lossiemouth, the

the whole of the country appeared to be formed of boulder stones; and, near to the town, great banks, evidently left by the retiring of the sea, make their appearance. These boulder stones are of granite, granitic porphyry, micaceous schistus, quartz, limestone, and arenaceous breccia. At Lossiemouth, which is a trifling village, I observed strata of red-coloured argillaceous sandstone; but no other rock was to be observed in the neighbourhood. We now walked along the shore for a considerable way, still over boulder stones; we then changed our course, and continued walking for several miles upon the road to Fochabers, when we found the country to improve very much in beauty. As this route did not seem very interesting, we again traversed the country until we came nearly to the mouth of the river Spey, which we crossed in a small boat. Here we walked along a beach of boulder stones, which was without any covering of heath, and was extremely fatiguing. Having reached its farther extremity, we walked, by a better road, to the fishing town of Buckie. Upon several parts of the shore, I observed the red-coloured argillaceous sandstone; and at Buckie the strata became nearly vertical. At this place, as far as I had leisure to determine, the secondary sandstone, which we had traced along the shore all the way from the Pentland frith, disappeared, the sea-coast being formed of primary strata. We now left the coast, and ascended for a lit-

tle, when we came upon a level, which continues for a considerable way either bare or heath-covered, and at a little distance is bounded by mountains of considerable height. As we approach to Cullen, the country becomes well cultivated; and we pass, to this sweet village, thro' very fine and rich plantations. It was almost dark before we reached Cullen, so that we probably passed richly-wooded scenes. The strata, all the way from Buckie, are entirely primitive, and are principally micaceous schists, traversed by quartz veins. In some places I observed masses of granite: but I had not time to determine its position with regard to the other rocks.

In the morning, we left with regret the delightfully-situated village of Cullen, and took the road which leads to Portferry. A little way from the town, the country loses much of its beauty, and the wood gradually disappears. About two miles from Cullen, we forsook the road, and walked towards the shore, to view the old castle, once the seat of Lord Oliphant. The castle is built upon the summit of a cliff about 80 feet high, which projects into the sea; and its ruins shew that formerly it must have been a place of considerable strength. The times are now happily changed. In place of the fortress perched upon the almost inaccessible sea-cliff, the seats of our chieftains are now placed in the most enchanting situations, and adorned with all the

the richness and luxurious variety of nature and art combined. It is a character which strongly marks the barbarism of former times, and the present happy change of manners and government. The rock, upon which this castle is situated, is composed of talcaceous schistus, which is disposed in strata that are nearly vertical, and is more or less intermixed with quartz. I also observed a great stratum of compact quartz, which is in some places between 16 and 17 feet wide. What is curious, this stratum has, in some places, the character of granular quartz; and it is often so intermixed with talc, as to form a species of talcaceous schistus. The strata of talcaceous schistus, upon one side of the stratum of quartz, are much twisted, while on the other they are perfectly regular.

We now continued journeying along by the sea-shore, that we might have a better opportunity of discovering any interesting appearances which were to be observed. The cliffs continue to Sandfide to be composed of nearly vertical strata of talcaceous and micaceous schistus; but, upon the south side of Sandfide, I observed a considerable stratum of steel-grey, foliated limestone, which lies upon an ardesia, or primitive argillaceous schistus, and this ardesia appears to be covered by a breccia. As the sea covered the greater part of this rock of breccia, I could not determine with certainty its position with regard to
the

the limestone. After passing this stratum of limestone, which, we were informed, runs a considerable way into the country, we came to an immense mass of breccia, which seemed to be quite insulated: it is not improbable, however, that, before the sea had washed away the talcaceous schistus, the breccia would have been observed covering it. We still continued our journey along the shore, until we came within a quarter of a mile of Portsoy; and, in that extent, I observed strata of talcaceous, micaceous and hornblende schistus alternating with each other. We now walked to the town, which we found to be irregular and dirty.

As the rocks upon the sea-shore, near to this town, are very interesting, we agreed to stay a day or two, and examine them particularly. I was the more anxious to do this, as they have long attracted the attention of mineralogists; but their particular geognostic characters have never been detailed in any publication. After having examined these rocks, the following is the result of the observations which I made.

About a quarter of a mile from Portsoy, at the place to which I had traced the strata in coming into the town, the talcaceous schistus appeared, in vertical strata; and, nearly at the same place, I observed a stratum of white marble, which is
marked

marked E, in the plan at the end of this volume. It is about 12 feet wide, and runs S. W. and N. E. which is in the same direction with the bounding strata *. It appears to have been worked for ornamental purposes, as I observed several blocks upon the beach which seem to have been sawed. To this stratum succeeds a vertical stratum of micaceous shist[†], marked F, which is compact, and of a blackish colour where in contact with the marble, but of a green colour where it is in contact with the next stratum, which is serpentine ‡. The stratum of serpentine, marked G, which succeeds to the talcaceous shistus, is of great width, and, like the other strata,

* This marble is white, or clouded with steel-gray, but it is much mixed with scales of talc.

† The talcaceous shistus, which alternates with these strata, has sometimes so much the appearance of compact micaceous shistus, that it cannot be distinguished from it; and as it approaches the marble, it is to be observed mixed with it, and passing into it.

‡ This serpentine is of various shades of olive and blackish green. Its fracture, which is either uneven, coarse splintery, or even fine splintery, presents canary-green scales. It is intermixed with various fossils, as asbestos, indurated steatites, talcite of Wallerius, calcaceous spar, and iron pyrites.

strata, is nearly vertical, and runs in a similar direction. It runs out into the sea like a great wall; and this, with its green colour, gives it a singular aspect. This stratum is bounded by a stratum of talcaceous schistus, H, which is almost entirely composed of quartz, where it is in contact with the serpentine; but as it approaches the next stratum which is marble, it has more of the talcaceous character, and is also traversed by veins of quartz. The stratum of marble, I, is from 15 to 20 feet wide; is also vertical; but is of a bad quality, and will not serve for any ornamental purpose. It has, immersed in it, pieces of quartz and talcaceous schistus. To this stratum succeeds a thin stratum of quartz; and this again is bounded by a thin stratum of talcaceous schistus, K. Both these strata are only a few feet wide; and are succeeded by a stratum of marble, L, nearly of the same width with the former stratum, I. To this marble succeeds a great stratum of serpentine, M, which is of the same nature with the stratum we have before described. This stratum is bounded by hornblende rock *, N, which forms the rocks that surround the harbour of Portsoy, and continues beyond it towards a bay, the name of which I do not recollect.

* The hornblende rock is generally schistose, and has sometimes scales of brown mica intermixed with it.

collect *. It is traversed in several places by veins of granite, which run in different directions, and vary in breadth from one to eight or nine feet. At a little distance from the side of the bay I have just mentioned, another stratum of serpentine, marked O, makes its appearance; and to it again succeeds the hornblende rock, P, which is traversed by veins of granite †.

We now walked along the shore by the bottom of this bay; and, upon its opposite side, in place of the hornblende rock, there are rugged cliffs of micaceous schistus, which is in some places alternated with quartz, and in others traversed by considerable granite veins. The micaceous schistus sometimes contains garnets; and the granite, which is great-grained, frequently contains crystals of feldspar and mica, and sometimes it has the appearance that is called pierre graphique.

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M m

Such

* The serpentine, as it approaches the hornblende rock, becomes gradually intermixed with it, and at last is not to be distinguished from it.

† Betwixt Portsoy harbour and the bay, I observed marble; but I could not determine how it lay with respect to the other rocks; so that I have not represented it in the plan.

Such appears to me the disposition and nature of the strata upon the shore at Portsoy*.

As the geognostic characters of the serpentine, at this place, are interesting, I shall here mention, for the information of my readers, a few facts, which shew that pretty nearly similar appearances have been observed in other countries. Zobtenberg, in lower Silesia, consists entirely of serpentine, in which some hornblende is found, and its strata are nearly vertical †. In the Miner's Kalendar for 1790, Kohler informs us, that serpentine and primitive limestone (marble) are nearly allied in their geognostic characters, and that sometimes they are disposed in strata which alternate. We are also informed that serpentine rests upon gneiss, and even alternates with it ‡, and also with quartzzy talcaceous schistus ||.

The

* Some travellers are of opinion that the serpentine and marble form great veins, rather than vertical strata.

† 4 Berl. Beobacht. 353.

‡ Charpentier Mineralogische Geographie von Churfachsichen Lande.

|| N. Nord. Beytrage. 149.

The appearance of the veins of granite traversing hornblende rock and micaceous shistus, is by no means uncommon in Scotland; and in other countries similar appearances have been very often observed. The pierre graphique has been observed, in Siberia, to form the sides of veins where the topaz is found*; but at Sebnitz it is disposed in beds with the common granite†; and, in the Uralian mountains, Herman observed it mixed with the common granite‡. Patrin, who found it in Siberia with the topaz, conjectures that it may generally be considered as indicative of the presence of these gems.

Having thus examined the strata upon the shore, I walked into the country for about two miles; but could observe no trace of the serpentine, or marble, or talcaceous shistus, but in several places I observed the hornblende rock. I ascended a hill a few hundred feet high; upon the side of it were masses of hornblende rock and gneiss scattered about, but towards the summit it was entirely composed of shistose quartz. This

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* J. de Physique. Ann. 1791.

† N. Bergmannisches Journal, B. 2. 443.

‡ Herman Mineralogische Beschreibung des Uralischen Geburges. B. 1. f. 144.

is a rare rock in Scotland ; nor has it been observed but in a very few places upon the continent.

We now left Portfoy, and continued our journey by a good road which leads thro' the country towards the town of Banff. At the bridge of Boyne, I observed a stratum of foliated limestone inclosed in the micaceous schistus, which is continued to this from Portfoy. We here observed a beautiful wooded dell, with a small river running thro' it, extending below the bridge, and we were told that it continued to the sea-shore. As it is in these places that good sections of the strata are often to be observed, we forsook the high road, and walked thro' it. At a little distance from the entrance, I again observed the limestone cropping thro' the strata of micaceous schistus ; and, farther down, our attention was arrested by the extensive ruins of the castle of Boyne, which is situated upon one side of the dell, and richly surrounded with wood. We continued our walk, and soon reached the opening of the dell, upon the sea-shore, where we observed considerable quarries of the primitive limestone. From this to Banff, we walked along the sea-shore, which is low and rocky ; and the strata, as far as I recollect, are principally composed of micaceous schistus, which passes, on one hand, to ardesia, and, on the other, to talcaceous schistus, and

and sometimes it is to be observed alternating with hornblende rock ‡.

Banff is pleasantly situated upon the side of a hill, which declines towards the sea-shore. It has a harbour, which is protected by a good pier. The whole town has a neat appearance; and the bustle of industry formed a striking contrast with the other towns we had passed thro'.

We intended to have continued our journey along the coast towards Peterhead; but, the weather being fine, we were desirous to reach Aberdeen, so that I might examine the granite, and its connection with the other strata. We therefore changed our route, and took the road to Turreff, which we reached before the close of the evening. The strata are, all the way, of primary formation, and principally of micaceous schistus and ardesia.

Having rested all night at Turreff, we left it early in the morning; but unluckily a thick fog was spread all around, and

‡ I have to regret the loss, both of the notes, and of the specimens which illustrate this part of my journey; so that what I here write is from memory.

and soon the rain began to pour upon us, and continued without intermission the whole day. We reached Aberdeen in the afternoon, drenched with rain, and much fatigued with our journey. The strata are, all the way, of primary formation, and similar to those I observed between Banff and Turreff.

We remained here several days, expecting the weather to moderate, so that I might have an opportunity of examining the structure and nature of the strata for five or six miles around the city, and thus to acquire a knowledge of the position and different appearances of the granite. In the meantime, I examined the granite which is in the neighbourhood of the town, and observed, in the bed of the river Don, that it is covered by micaceous schistus, and that it seemed to be disposed in great strata, or beds. It has very often crystals of hornblende intermixed with the felspar and quartz.

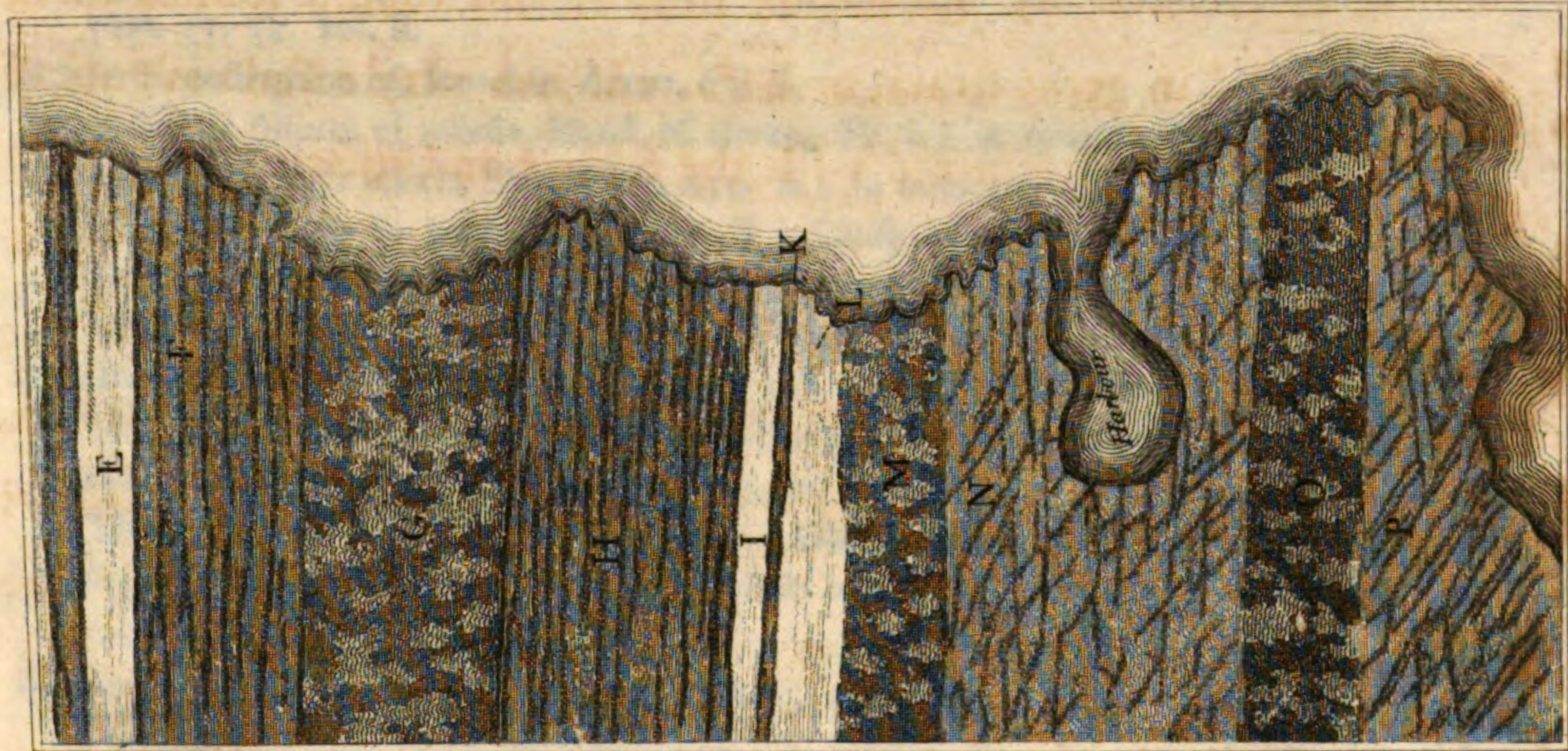
As the weather still continued stormy, we were obliged to defer the examination of this country until another season. Having taken leave of our friends, to whose kind attention we had been so much indebted during our stay at Aberdeen, we set out for the banks of the Forth.

The primary strata of micaceous schistus continues for two
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or three miles after leaving the town; when it is succeeded by red-coloured argillaceous sandstone, and sandstone breccia.

At Stonehaven, which is about 14 miles from Aberdeen, we observed the ruins of the castle of Dunotter, situated upon a rock of breccia.

From this, by Montrose, Dundee, through a fine country called the Carse of Gowrie, to Perth; and from that, by Cupar in Fife, to the banks of the Forth; the whole strata are of secondary formation, and belong either to the transition or stratified rocks.



Plan of the Strata near Portsoy Harbour.

or three miles after leaving the town; when it is succeeded by red-coloured argillaceous sandstone, and sandstone breccia.

At Stonehaven, which is about 14 miles from Aberdeen, we observed the ruins of the castle of Dunrobert, situated upon a rock of breccia.

From this, by Monro's, Dundee, through a fine country called the Cairn of Gowrie, to Perth; and from that, by Cupar, in Fife, to the banks of the Forth; the whole tract is of the condary formation, and belongs either to the transition or the fixed rocks.



Sketch of the country between Aberdeen and Perth.

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